UWR Rainwater Offset Unit Standard

(UWR RoU Standard)

Concept & Design: Universal Water Registry

www.uwaterregistry.io

UWR Project Concept Note & Monitoring Report (PCNMR)

Project Name: Artificial Wetland Groundwater Recharge Project by ZIPL, Gujarat, India

PCNMR Version 1.0

Date of PCNMR: 19/01/2024

1st RoU Crediting Period: 01/01/2014 to 31/12/2023 (10 years, 00 months)

1st RoU Monitoring Period: 01/01/2014 to 31/12/2023 (10 years, 00 months)

UWR RoU Scope: Scope 2

UNDP Human Development Indicator: 0.645 (India)

RoUs Generated During 1st Monitored Period: 1305863 RoUs

A.1 Location & Details of Project Activity

Title	Artificial Wetland Groundwater Recharge Project by ZIPL, Gujarat, India
Type and Scope of RoU Project Activity	Small Scale Project Inland Wetland Type *Scope 2: Measures for conservation and storage of unutilized water for future requirements including freshwater ecosystems and wetlands.* Groundwater recharge freshwater wetlands are man-made wetlands constructed on sandy soils that allow water to gradually percolate through the soil and recharge the aquifer. The project activity involves several artificial recharge pits for retaining rainwater runoff and function as artificial wetlands that helps recharge the groundwater in the area. The PP showcases efficient methods to replenish depleted groundwater supplies as a key corporate environmental intervention towards a more water secure India.
Total Current Area of Recharge/Catchment	460808 m^2
Address of Project Activities	PHARMEZ Special Economic Zone, Zydus Infrastructure Pvt. Ltd., Village: Matoda, Taluka: Sanand Latitude: 22°52'49.25"N Longitude: 72°24'23.60"E
State	Gujarat
District	Ahmedabad
Country	India
Block Basin/Sub Basin/Watershed	Cambay Basin
Water Type	Freshwater
Project Commissioning Date	2012
Rivers and water bodies near the project activity	Sabarmati River: 9 km to the East
SDG Impacts (7)	1 – SDG 1 End poverty in all its forms everywhere 2 – SDG 6 Ensure access to water and sanitation for all 3 – SDG 14 Life below water 4 – SDG 15 Life on Land 5 – SDG 11 Make cities and settlements sustainable

	6 – SDG 17 Strengthen global partnership for sustainable development 7 – SDG 13 Climate Action
Climatic Conditions	Annual Mean Maximum Temperature: 34.4°C Annual Mean Minimum Temperature: 21°C Annual Mean Maximum Rainfall: 62.6 mm

Calculated RoUs per year

Period (DD/MM/YYY-DD/MM/YYYY)	Total RoUs (1000 litres) /yr UCR Cap (1 million RoUs/yr)
01/01/2014-31/12/2014	142988
01/01/2015-31/12/2015	104062
01/01/2016-31/12/2016	82199
01/01/2017-31/12/2017	142732
01/01/2018-31/12/2018	74919
01/01/2019-31/12/2019	209972
01/01/2020-31/12/2020	225499
01/01/2021-31/12/2021	127964
01/01/2022-31/12/2022	75320
01/01/2023-31/12/2023	120208
Total RoUs	1305863

A.2. Project owner information, key roles and responsibilities

Project Proponent (PP):	**Project Owner**: Zydus Infrastructure Pvt. Ltd (ZIPL), Ahmedabad, Gujarat
UWR Project Aggregator	**Aggregator**: Kapil Acharya **UCR ID**: 623322759
Contact Information:	kapilacharya@zydusinfra.com

Date PCNMR Prepared	19/01/2024
External Links and Reports	WETLAND BIRDS AT PHARMEZ, Survey Report by Dipak A Maroo Nayana D Maroo, 2021-2022 AQUIFER MAP AND MANAGEMENT PLAN, AHMEDABAD DISTRICT, GUJARAT STATE, CENTRAL GROUND WATER BOARD WEST CENTRAL REGION GUJARAT DECEMBER 2021

Purpose of the project activity:

Zydus Cadila, group of companies, is a fully integrated global healthcare and pharmaceutical provider, which has set up a Pharmaceutical Special Economy Zone (SEZ) called "Pharmez", about 25 kilometers from Ahmedabad, Gujarat. The Zydus group has undertaken focused efforts towards water and wastewater recycling and reuse across all of its operations in India.

The project proponent is M/s. Zydus Infrastructure Pvt. Ltd (ZIPL or PP) who has setup groundwater recharge wetlands (man-made wetlands) that allow water to gradually percolate through the soil and recharge the aquifer within the project boundary. The PP has left many plots vacant within the SEZ to create such recharge wetlands in order to recharge groundwater with rainwater run-off through natural percolation. These recharge wetlands also attracts various species of migratory birds, hence helping promote biodiversity within the project boundary.

The artificial wetlands minimize ecological disturbance, thereby protecting the natural biodiversity of the SEZ. **There were no water bodies within the project boundary site when the SEZ was commissioned in 2006.**

Wetlands are areas where water covers the soil, or is present either at or near the surface of the soil all year or for varying periods of time during the year, including during the growing season.

Wetlands, such as the project activity, are amongst the most productive nature based ecosystems for water conservation for the following reasons:

- They support and establish habitats for aquatic flora and fauna and support all forms of life under water,
- They filter sediments and nutrients from surface water, purify water and mitigate floods,
- They maintain stream flow, recharge groundwater and provide industrial water for future captive use,
- They control the rate of runoff in urban areas and provide natural buffer shorelines against erosion,
- They stabilize local climate and are an important centre for tourism and recreation, and;
- They represent the floristic diversity of the area.

Water saturation (hydrology) largely determines how the soil develops and the types of plant and animal communities living in and on the soil. Wetlands support both aquatic and terrestrial species. The prolonged presence of water creates conditions that favor the growth of specially adapted plants (hydrophytes) and promote the development of characteristic wetland (hydric) soils.

The PP has employed this voluntary groundwater aquifer recharge via rainwater harvesting measure within the project boundary to ensure regular water supply and availability for future captive use during the industrial development within the SEZ. The PP maintains the wetland with a view to ensure sufficient water exists to maintain the desired level of their ecological health. Such project activities are an engineered sequence of water bodies designed to collect rainwater runoff and are an example of nature-based solutions to mitigate the impacts of climate change..

Eventually, all the vacant plots that are currently being operated as wetlands, will be developed with industrial units. The PP has voluntarily planned, designed and operated the wetlands to provide a range of services well beyond the primary aim of groundwater recharge, to include habitat and wildlife diversity, bird and wildlife watching, water storage during periods of shortage and excess, and aesthetic value in within the SEZ.

Boundary wall around the wetland prevents outflow

Wetland birds at the project site

The availability of source water, one of the prime requisites for ground water recharge, is basically assessed in terms of **unutilized surplus monsoon run off.** This component is key to quantification of water credits under the UCR RoU program and can be assessed by

analyzing the monsoon rainfall pattern, its frequency, number of rainy days, maximum rainfall in a day and its variation in space and time. The variations in rainfall pattern in space and time, and its relevance in relation to the scope for artificial recharge to sub-surface reservoirs can be considered for assessing the total water credits available to the PP.

Artificial wetlands and ponds, filled with static water, play a crucial role in maintaining the ecological balance, by acting as a home to birds and animals, while also playing a key role in absorbing rainwater, thus controlling floods.

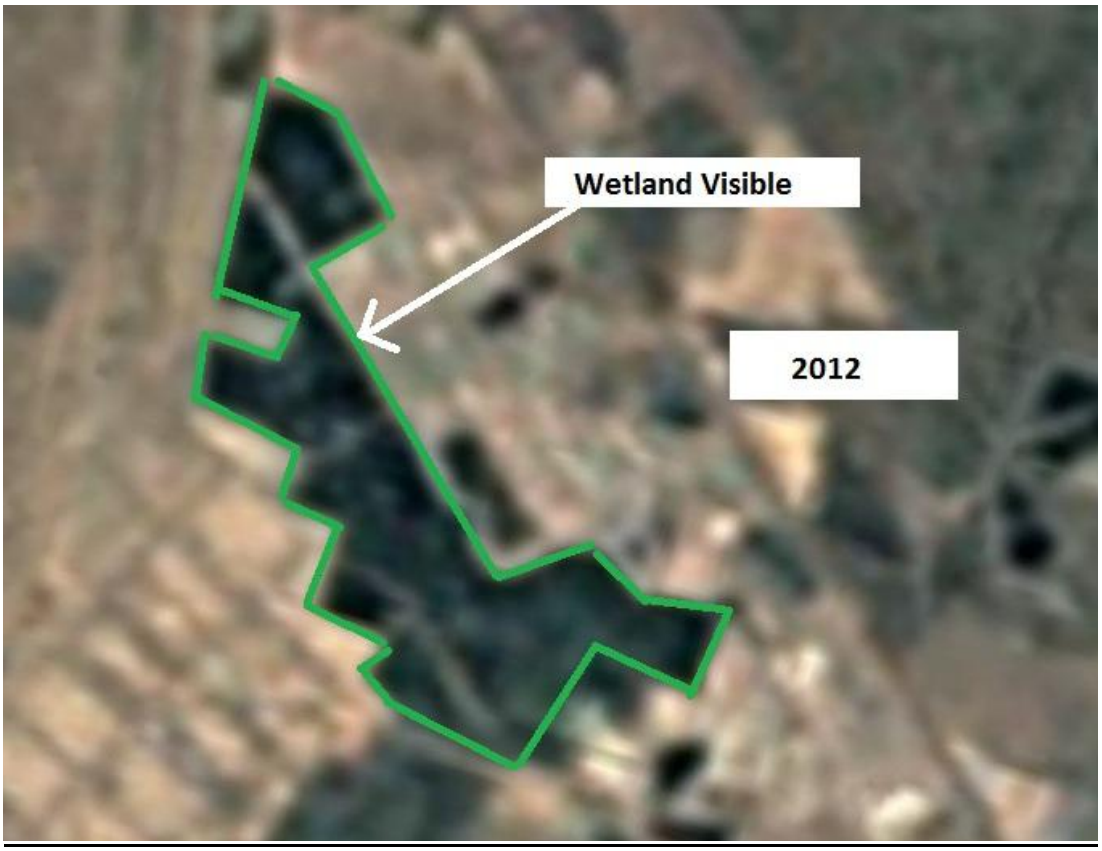
As regards the overall capacity of water body, the PP has confirmed that total area covered by water bodies is 48 hectares. Since it is a large area, the overall capacity is estimated based on the approximate depth for **dug-out water bodies as four (4) feet**. Based on the above calculation (48 Hectares i.e, 51,66,677 sq.ft X 4 feet), the overall capacity of wetland is 2,06,66,708 cubic feet (58.52 crore litres).

These artificial wetlands enhance the microclimate and improve the ground water table (and will effectively do so) till all the vacant plots are developed as part of the SEZ. Given the fact that most of the impacts of climate change in the country would be water mediated, the role of wetlands in climate change demands urgent attention and integration in the mitigation and adaptation strategies. As part of response narrative to protect & restore 100% of the existing water bodies, the PP has confirmed that there are two types of water bodies available at PHARMEZ - Artificial water pond and water retention pits.

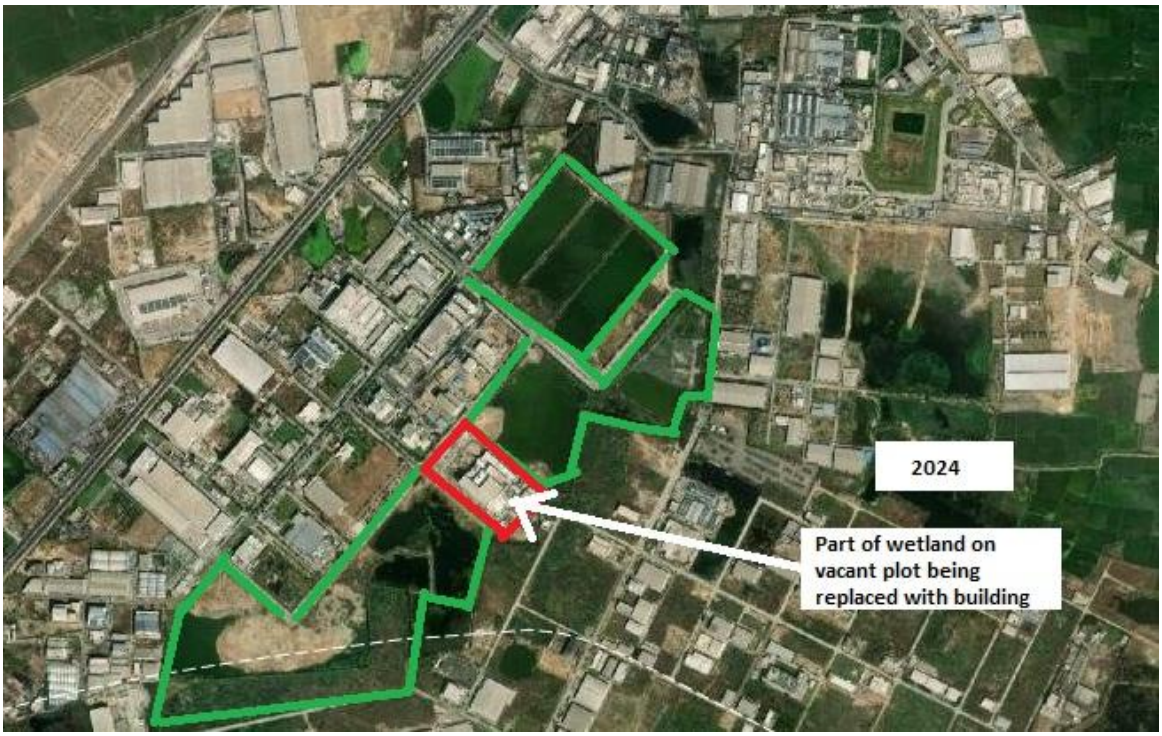
Artificial water pond is specifically designed for hydroponic practices. It is located adjacent to the lounge and garden area. This pond is proposed to be maintained and retained for lifetime of the project and PHARMEZ is in process of building similar ponds in the near future. The vacant plots on the other hand, currently housing the artificial retention pits and wetlands that will be eventually occupied by buildings and commercial manufacturing units.

Secondly, the rainwater retention pits are formed as a result of unsold open plots that are being used for runoff water retention and groundwater recharge through natural percolation. These pits (as stated earlier) are a temporary measure to attempt water conservation practices. This confirms that the PP is committed to water conservation practices at each and every part of the SEZ to minimize ecological disturbance, thereby protecting the natural habitats. The commissioning date is **2012** for the project activity.

(Source: Google Earth Historical Pictures 2006-2007)



(Source: Google Earth Historical Pictures 2012)



(Source: WRIS India 2024)

Biodiversity is supplemented by the PP with an afforestation program within the project boundary wherein a total of 28,500 trees and saplings have been planted since 2015 till date. Such measures restore site specific fauna within the project boundary.

Faunal species recorded in the study area includes 8 types of mammals, 10 types of birds and 7 types of Reptiles. None of the sighted animal species can be assigned endemic species category of the study area.

The most commonly spotted bird species within the project activity are: Cattle Egret, Purple Heron, Pond Heron, Black Ibis, Blue Rock Pigeon and Ring Dove

The project activity also attracts bird species that are under the protected list as follows:

- *Sarus carne, (Antigone antigone) and Woolly-necked Stork (Ciconia episcopus) which are in vulnerable category as per the IUCN red list;*
- *Black-headed Ibis (Threskiornis melanocephalus) and Oriental Darter(Anhinga melanogaster) are grouped under near threatened category of IUCN.*
- *Some birds, reptiles and mammals within the project activity are also protected ny the Indian Wild Life (Protection) Act, 1972 under different schedules.*

In Gujarat, over the recent years, increasing abstraction to meet rising demand for domestic supplies and irrigation has raised concerns for the sustainability of the resource and the livelihoods it supports. Consequences of overexploitation of groundwater include declining water levels and increasing competition for scarce water resources between domestic and agricultural users and rural and urban communities. Ground water level range from 5 to 10 m bgl at the project site.

The formal approval for the SEZ was received in June 2006 and the permission from Gujarat Ground Water Authority and Gujarat Pollution Control Board was received in September 2006, as per available records.

In the absence of the project activity, the PP would have not constructed artificial retention pits and rainwater runoff would be diverted to the storm water drains that currently facilitate the collection of rainwater run-off from the hardscape areas (roads, pedestrian pathways). The slope of storm water drain is directed from the far ends of the SEZ towards the main gate, where it meets the city storm drain at the main road and hence no groundwater recharge would occur within the project boundary.

The project activity qualifies under the UWR RoU program since the PP has undertaken *measures for conservation and storage of unutilized water for future requirements via wetlands*. Human-made non-state wetlands on private land are also approved under the UWR standard

(source: *Page 2, UWR Rainwater (RoU) Standard, UCR Wetland Guidance Document (India) 30/03/2023*).

The project activity showcases best-in-class preservation measures that need to be undertaken for the groundwater-dependent ecosystems in the state, since water retention at the local recharge areas of the wetlands helps in the mitigation of water level decline under present-day conditions.

As the regional water table continues to decline, comprehensive nature based water retention solutions will be needed in the whole state. The project activity highlights the impact of wetland–groundwater interaction at the corporate level is essential for the preservation of wetlands and for successful water retention planning.

There is no incentive today for any industry to implement or construct wetlands or artificial groundwater recharge structures on vacant plots within their project boundary.

By selling water credits from such conservation activities, industries (even those outside the pharmaceutical industry) can overcome the cost barrier to successful implementation and scale of such water conservation project activities.

The project activity by the PP is a positive step in the adoption of natural water conservation ecosystems required to be built at the speed the climate crisis demands before 2030.

Wetland Scenario:

In India, a ***johad***, also known as a ***pokhar*** or a ***percolation pond***, is a community-owned traditional ***harvested rainwater storage wetland*** principally used for effectively harnessing water resources in the states of Haryana, Rajasthan, Punjab, and western Uttar Pradesh of North India.

This johad type of structure is similar to the project activity, since it collects and stores water throughout the year, to be used for the purpose of recharging the groundwater in the nearby water wells for future captive industrial use within the SEZ. Johads also cater to resident and seasonal migrant birds as well as wildlife animals from the nearby bani (forest). Indian state fisheries departments also promote the use of these johads for raising fishes on contract basis for commercial fishing.

Johads are often seen surrounded by embankment, with water well and trees around them. In many parts of India, especially in dry state of Rajasthan, where the annual rainfall is very low (between 450 and 600 mm) and the water can be unpleasant to drink, rainwater runoff during the months of July and August is stored in such johads and used throughout the year. A similar structure to a johads, is called a khadin, which consists of a very low and long earthen bunds and can be found in the Jaisalmer district of India.

India has announced the Atal Bhujal Yojana (Atal groundwater scheme) in 2019, which is a 5 year (2020-21 to 2024-25) action plan (costing INR 6 billion (US$85 million)) aimed at johad rejuvenation (wetland) and groundwater recharge, across 8,350 water-stressed villages across 7

states, including Haryana, Rajasthan, Gujarat, Madhya Pradesh, Uttar Pradesh, Karnataka, and Maharashtra.

Analysis of published land use and land cover data from 22 cities in India by Wetlands International South Asia team indicates that during 1970 – 2014, every one square kilometre increase in built-up area matched up with a loss of 25 ha wetlands. The most rapid loss was seen in metros, namely New Delhi, Bangaluru, Chennai, Mumbai and Hyderabad.

Some johads also have bricked or stones masonry and cemented ghat (series of steps and/or ramp). India's annual fresh water withdrawals were about 500 billion cubic meters and the Indian industry consumed about 10 billion cubic meter of water as process water and 30 billion cubic meters as cooling water.

As per the World Bank studies, the water demand for industrial uses and energy production will grow at a rate of 4.2 percent /year, rising from 67 billion cubic meter in 1999 to 228 billion cubic meter by 2025. Therefore, according to World Bank the current industrial water use in India is about 13 per cent of the total fresh water withdrawal in the country. Cost of water supply varies widely and can be in the range of Rs. 0.09 to 50.0 per cent cubic meter (source).

A.2.1 UWR RoU Scope & Project Details

UWR **RoU Scope 2**	*Measures for conservation and storage of unutilized water for future requirements including freshwater ecosystems and wetlands.*

Being a leading pharmaceutical and a socially responsible corporate with excellent ESG credentials, the PP decided not to consume/burden the village's existing clean drinking water resources or construct deep bore wells to further deplete the surrounding groundwater aquifers, but instead opted to voluntarily treat, recycle and reuse wastewater for the captive water requirements of all units within the SEZ.

In the absence of the project activity, the PP would have not harvested rainwater run-off and would have constructed industrial structures on the vacant plots within the project boundary.

Artificial recharge is the practice of increasing the amount of water that enters an aquifer through human-controlled means such as artificial ponds and wetlands.

Baseline scenario

The baseline scenario is the situation where, the PP, in the absence of the project activity, would have not constructed artificial retention pits and rainwater runoff would be **diverted to existing** the storm water drains that currently **already facilitate** the collection of rainwater run-off from the hardscape areas (roads, pedestrian pathways). The slope of storm water drain is directed from the far ends of the SEZ towards the main gate, where it meets the city storm drain at the main road and hence no groundwater recharge would occur within the project boundary.

Hence the baseline scenario is:

Hence the baseline scenario applicable is: *"the net quantity of rainwater runoff captured/harvested each year and/or transmitted towards groundwater recharging."*

Water Conservation and Recharge Efforts within the State:

In Gujarat, the coastal and inland wetlands cover 35.8 % and 6.0 % of the total wetland area respectively in India. The state recognised the value of important wetlands related to geo-morphology, ecology, flora and fauna and constituted nine Protected Areas - one national park,

seven sanctuaries and one conservation reserve to preserve a total area of 13,052 sq. km. Additionally, eight wetlands of national conservation significance have been identified and notified by the Ministry of Environment & Forests, Government of India for their conservation in partnership with the local communities (source).

Details of recharge structure constructed by different State Government department till 31/03/2018.

Name of District	Check Dam	Bori Bandh	Khet Talavadi	Deepening of Ponds
AHMEDABAD	1255	4946	13010	1894

(Source GWRDC, Gandhinagar)

Further, these wetlands are classified into different sub-types such as Natural lakes, waterlogged areas, Reservoirs, Village Tanks and Ponds, Marshlands, Mangroves, Coral reefs, Mudflats, Saltpans and others. In Gujarat, the coastal and inland wetlands cover 92.3% and 7.7% of the total wetland area, respectively highlighting the importance of this ecosystem. Ever increasing industrial activities in close vicinity of this ecosystem signifies its conservation importance calling for exhaustive and sustained study.

The wetlands in the state have special international significance. The western most part of the state is recognized as the gateway of migratory waterfowl that come into the sub-continent. The wetlands of the state are major wintering areas for cranes, pelicans, terns, ducks, and shore birds (mainly waders). These birds are highly dependent on the village tanks and storage reservoirs.

Great Rann of Kachchh, Khijadiya Bird Sanctuary, Little Rann of Kachchh, Nalsarovar, Nani Kakrad (Navsari), Pariej, Thol Bird Sanctuary and Wadhwana are the eight wetlands of national importance identified by Ministry of Environment, Forest and Climate Change for implementing National Wetland Conservation Programme (source).

Wetlands as nature-based solutions (NBS) for water management

Wetlands perform as NBS to reduce levels of contaminants in surface waters by moderating the adverse water quality impacts of soil erosion, runoff, and wastewater contamination. Wetlands buffer the degradation of water quality by retaining pollutants due to mechanical processes (i.e., sedimentation, filtration), adsorption on the substrate, biosorption and other more complex and interlinked processes between plants and microorganisms, and disinfection due to UV radiation from sunlight.

They have been proven to be capable of removing a number of organic and inorganic substances (e.g., nutrients, heavy metals, pesticides, hydrocarbons, xenobiotics, antibiotics) from contaminated water. These pollutants may originate from storm-water in agricultural areas], urban surfaces (e.g., roads), municipal wastewater (especially from small urban

agglomerations without access to municipal grids), landfill leachate, aquaculture effluents, and specific industrial wastewaters.

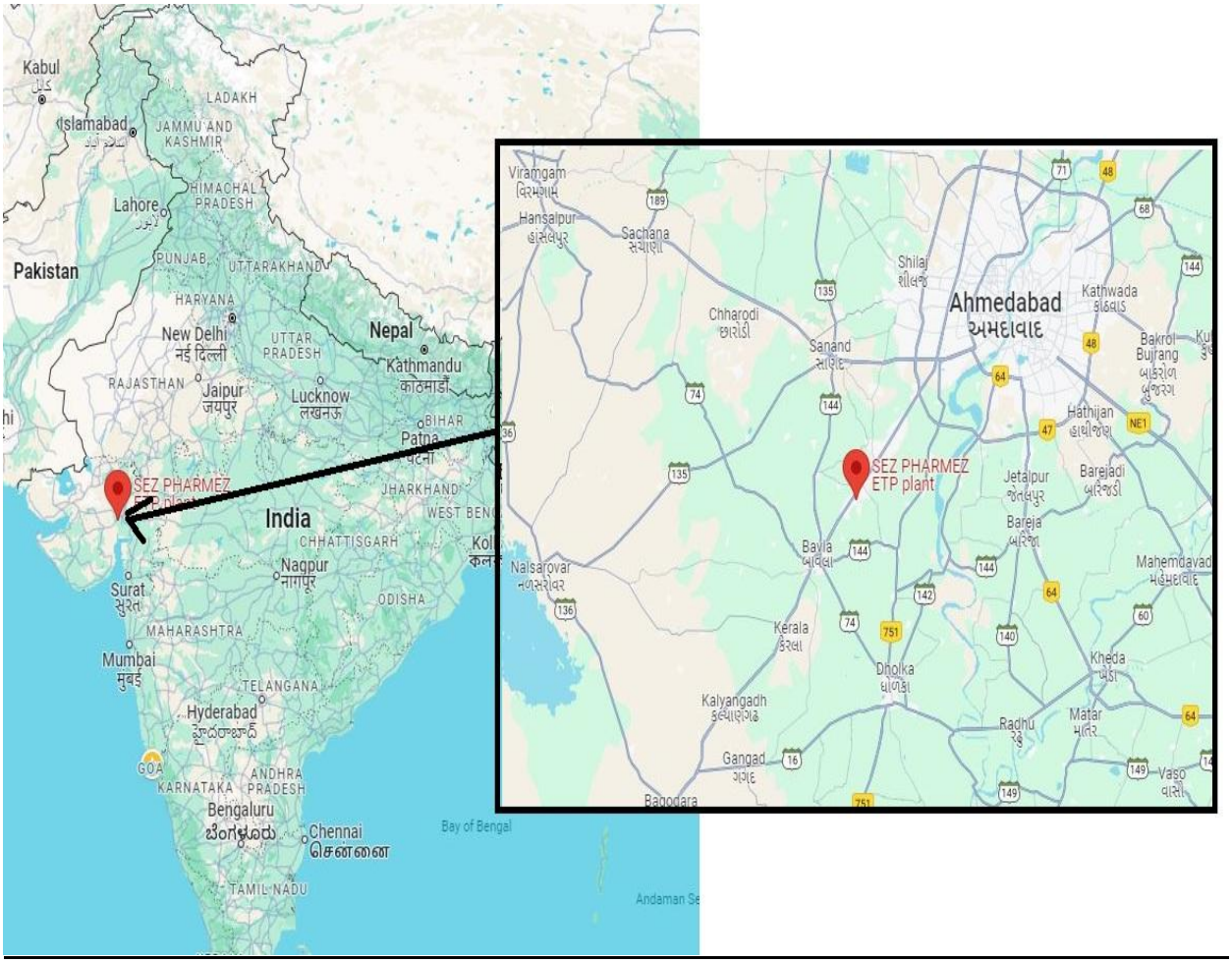
Constructed wetlands have been widely used as an alternative in wastewater treatment (both as secondary and tertiary treatment) in different climate regions (temperate, cold, tropical) and particularly in developing countries due to their low cost. Wetlands can remove up to 90% of the sediments present in rainwater runoff (source).

Despite the overall apparent shortage of water, there are few incentives for efficient use of water or recharging and conservation efforts in India or in many parts of the world, the UWR RoU program is the only voluntary water incentive program for such project activities.

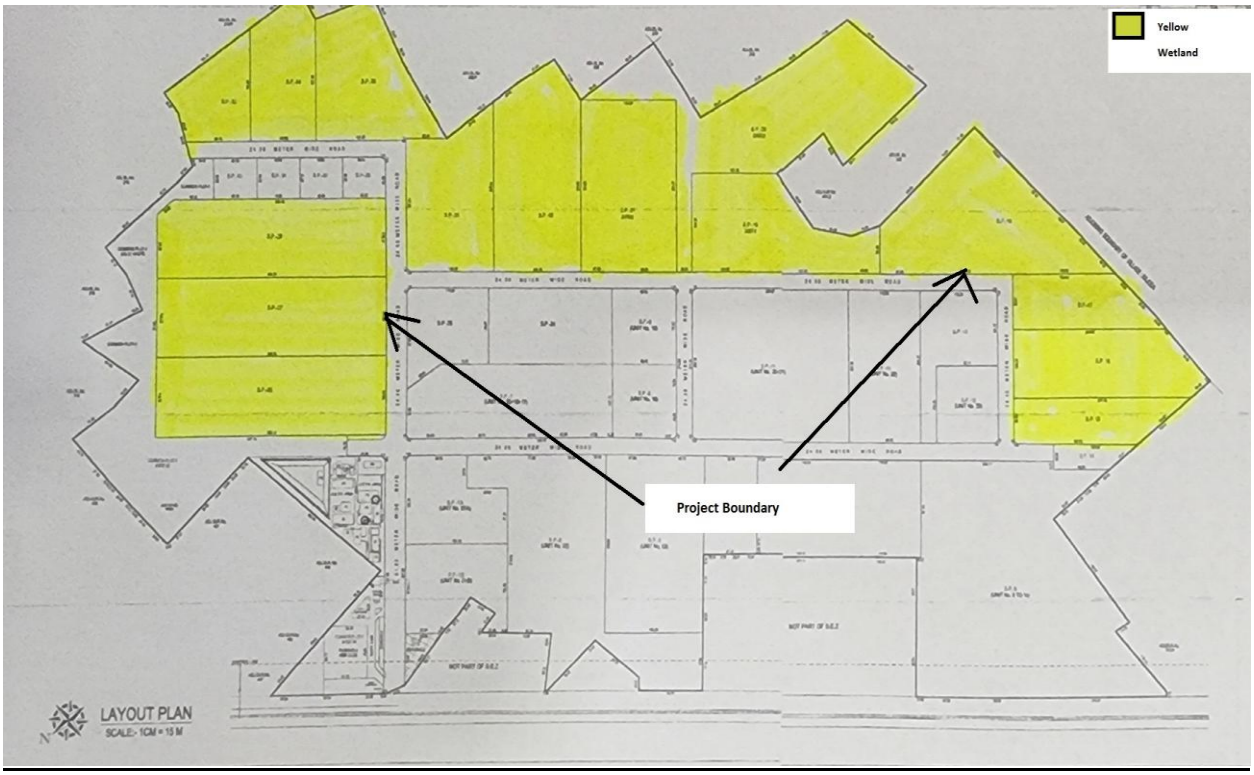
Most countries have not developed instruments (either regulations or economic incentives) and related institutional structures for reallocating water between sectors, or for internalizing the externalities which arise when one user affects the quantity and quality of water available to another group.

Project Location

PHARMEZ Special Economic Zone,
Zydus Infrastructure Pvt. Ltd.,
Village: Matoda,
Taluka: Sanand
Latitude: 22°52'49.25"N
Longitude: 72°24'23.60"E



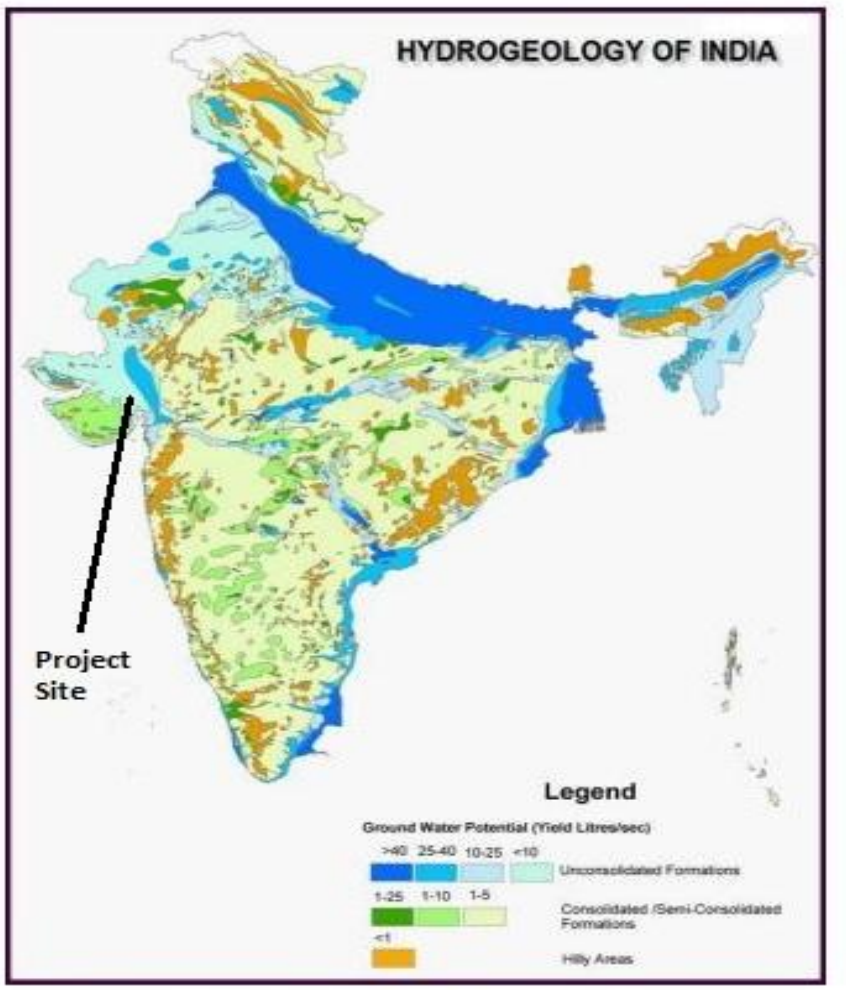

Matoda
Zydus Infrastructure Pvt Ltd
Aadesh Industries - Plastic Bottle...
Special Economic Zone(SEZ...
47
MAMA Amazon
Zydus Hospira Oncology Pvt. Ltd.
Intas Pharmaceuticals Ltd. SEZ Plant
47
Mylan Laboratories Limited
Bueno Salud Care India Private Limited
Project Site
Stallion Laboratories Pvt. Ltd. - Unit-II


Yellow
Wetland
Project Boundary
LAYOUT PLAN
SCALE:- 1CM = 15 M

A.3. Land use and Drainage Pattern

HYDROGEOLOGY

As per CGWB 1997 report, part of Taluka -Sanand is categorized in overexploited block. As per collected inventory quality of ground water is good at Kavitha, Moraiya & Chacharvadi Vasna; while slightly saline at Changodar, Modasar, Moti Devti, Bhat, Bavla, Sanand, Pipan & villagers are using it for domestic utilization. At Bavla, Sanand & Piapan bore well water gets mixed with Narmada water pipe line in underground/overhead tank before it is supplied to village.

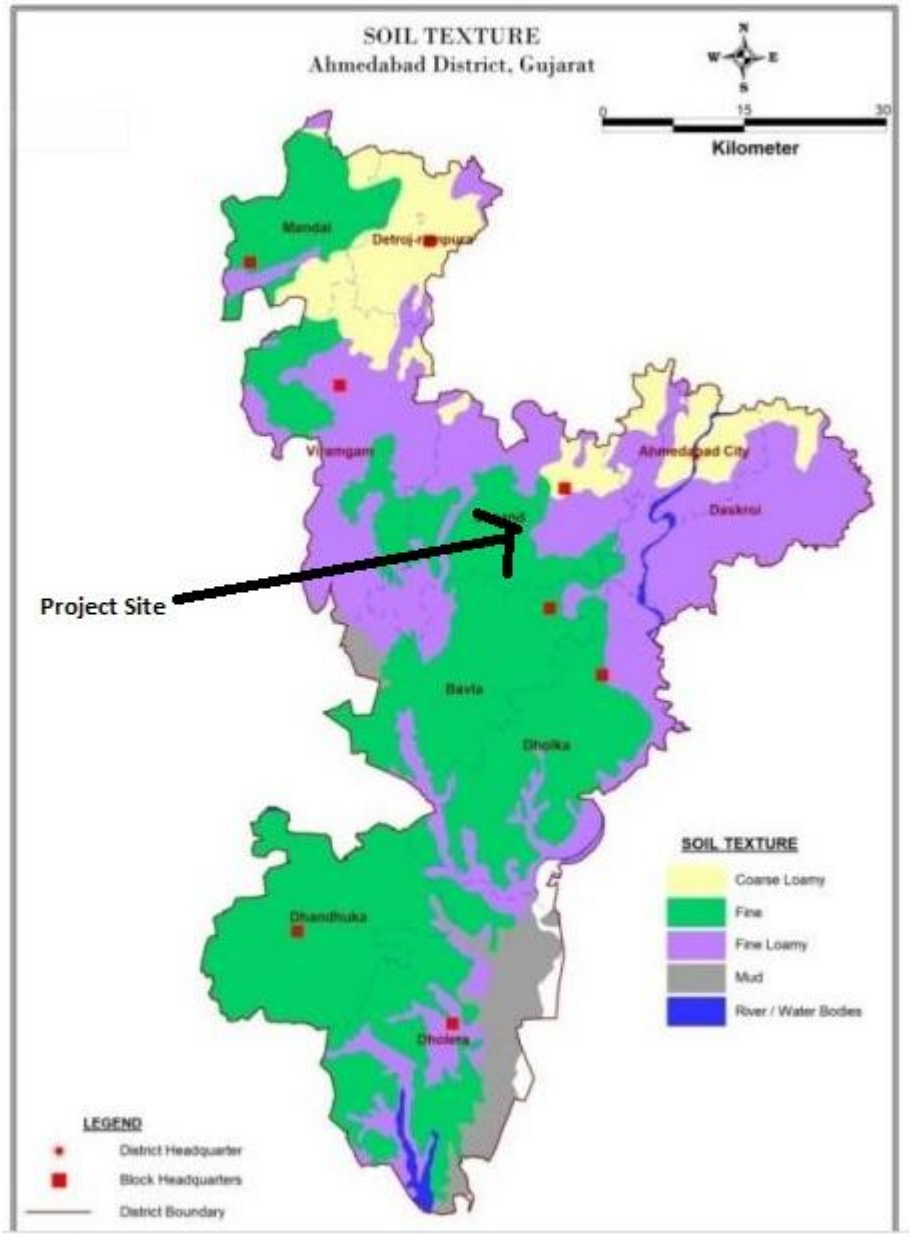


Hydrogeology of India

Master Plan for Artificial Recharge to Groundwater in India (2020) – A CGWB Compilation

Over recent years, increasing abstraction to meet rising demand for domestic supplies and irrigation has raised concerns for the sustainability of the resource and the livelihoods it supports. Additionally, changing land use as well as hydrological interventions and climate change will have impacts on natural recharge and groundwater storage.

Consequences of over-exploitation include declining water levels and increasing competition for scarce water resources between domestic and agricultural users and rural and urban communities. The district forms a part of the Cambay Basin.



WATER LEVEL

The project area falls under South Gujarat heavy rainfall Agro Climatic Zone (GJ-4)Agro Ecological Sub Region-2.3, characterized by 1-3 % soil slope, soil depth >1 m. The annual average rainfall is 700-800 mm. The main sources of irrigation are Bore well (44.98 %), Canal (23.77 %) & Open Well (20.0 %).

Quality of groundwater is mixed (good and slightly saline) as per existing sources in core/buffer zone of studied area. Ground water movement is towards south and south west area which is towards Gulf of Khambhat.

The project site area is covered by the unconsolidated alluvial deposits whose alternate sand and clay formations form the multi-aquifer systems. Ground water occurs both under phreatic as well as confined conditions.

The water level in the studied area is shallow below ground level in post monsoon season. The average seasonal fluctuation is 4 m as per hydro geological inventory of the wells and as per regional data of CGWB. The subsurface strata of the area reveal that thickness of unconsolidated formation persisting upto deeper depth helps in seepage and underground movement.

Decadal Average Depth To Water Level Pre-monsoon (2008-2017):

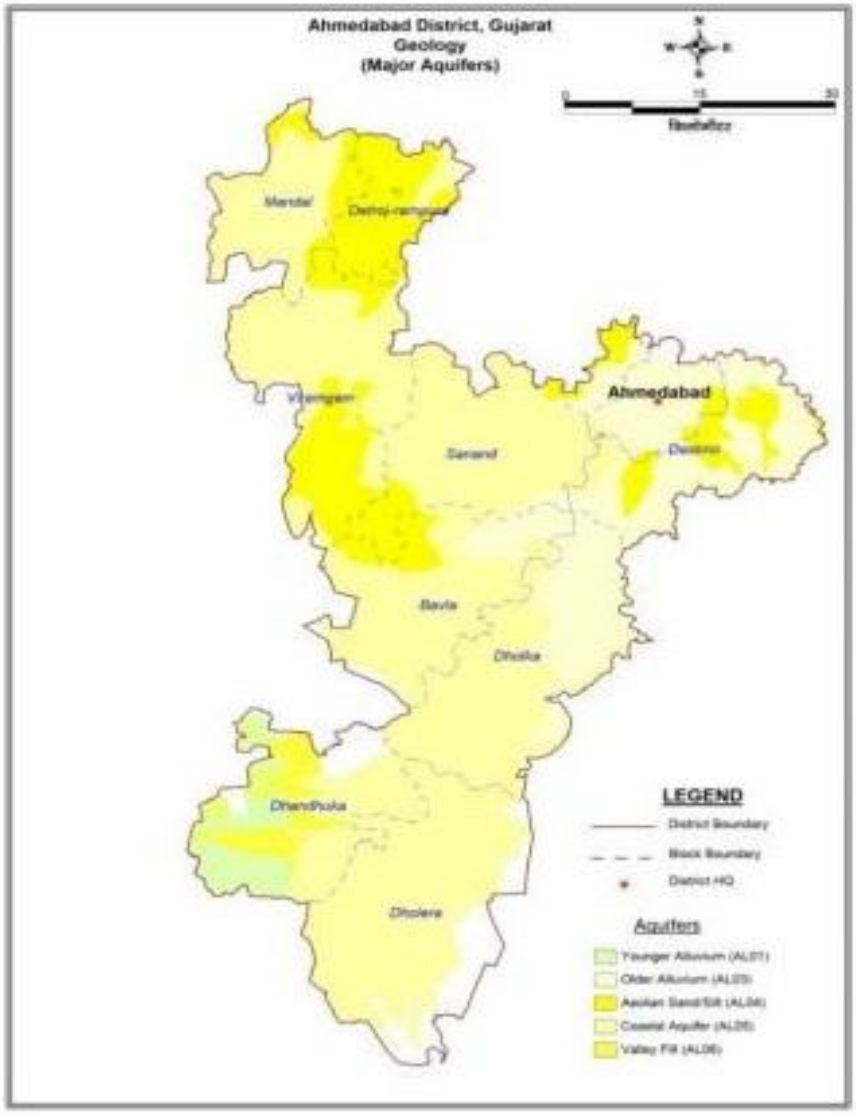
The pre-monsoon decadal average depth to water level in the district, ranges between less than 2m to >40m below ground level (bgl). In major part of district mostly observed decadal average depth to water level less than 10m bgl.

Decadal average depth to water level ranges between 10 m and 40 m bgl were observed in central part, eastern part and in small patches in northern part of district. Deeper decadal average depth to water level more then 40 observed in north-eastern part of district.

Decadal Average Depth To Water Level Post-monsoon (2008-2017):

The post-monsoon decadal average depth to water level in the district, ranges between less than 2m to >40m bgl. In major part of district mostly observed decadal average depth to water level less than 10m bgl.

Decadal average depth to water level less than 2m bgl were observed in southern part of district. Decadal average depth to water level ranges between 10 m and 40 m bgl were observed in central part, eastern part and in small patches in 33 northern part of district. Deeper decadal average depth to water level more then 40 observed in north-eastern part of district.

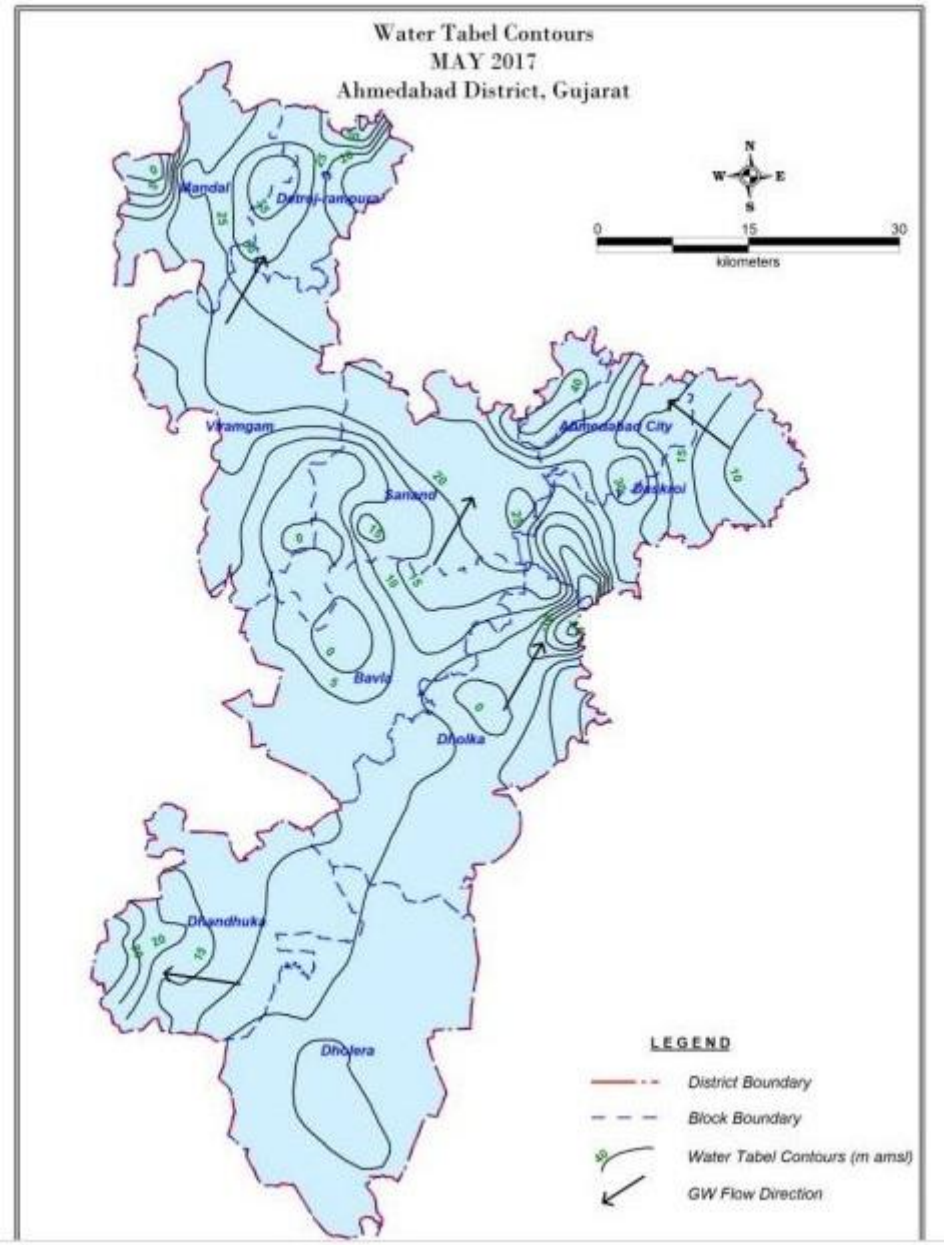


Geology of Ahmedabad District.

A geotechnical investigation report for an effluent treatment plant project within the project boundary by the PP (dated 11/2014), confirmed that the ground water table was at a depth of 1.5 depth below EGL and the sub soil profile was clayey soil of intermediate to high plasticity upto 1.5m. Another geotechnical investigation report at the SEZ (dated 05/2018), confirmed that the ground water table was encountered at a depth of about 2 m below existing G.L.

So lateral as well as vertical movement of seepage will be more (more permeable formation, approx K= 10-2 cm/sec), therefore effective measures are applied by the wetland. As per hydro inventory data, the quality of ground water in the dug well zone (up to 20 mbgl) is fresh, having

TDS < 1000 ppm in post monsoon. The semi-confined aquifers encountered in the depth range of 75 to 130 m bgl have ground water with TDS around 2000 ppm.



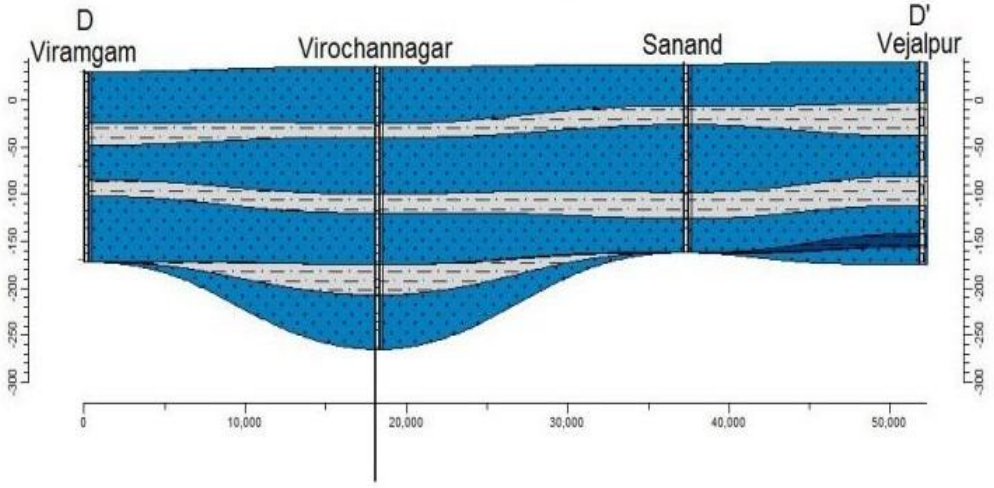
However, the CGWB (Central Ground Water Board) data show that during pre-monsoon period, deeper aquifer TDS quality is reported even up to 3000 ppm in some isolated cases. The regional confined aquifers between the depth ranges of 130 m bgl to a maximum depth of 350 m bgl have potable water with TDS less than 2000 ppm.

The normal average rainfall of Ahmedabad region is around 557 mm for month of July and September as per the India Meteorological Department (IMD) data. However, the rainfall recorded at nearest Sanand Rain Gauge Station during the period 2007- 2009 shows that average rainfall is 795 mm. Based on geomorphic and hydro geological studies, it was found that the existing ponds in Matoda gram panchayat of Sanand block are suitable for harvesting additional rainwater runoff.

Aquifer wise Hydrogeological Properties

Aquifer Group	Depth of occurrence of top of Aquifer	Generalized Thickness	Yield (lpm)	Quality/TDS (ppm)	Transimissivity (m2/day)	Water Level/ Piezometric head (mbgl)	Aquifer Type
Unconfined Aquifer	0 to 78	24 to 78	0.4 -780	560 to 63999	1.78- 687	0. to 42.22	Phreatic
Confined Aquifer I	43 to 136	18-72	0.80-900	783-4400	56.87-861	12.72-100.85	Confined
Aquifer Group II (Confined III & IV)	78 to 350	15-101	1.32-696	780-39200	11 to 86	8.3-125.1	Confined

Hydrogeological Cross Section along Viramgam- Vejalpur (D-D'), Ahmedabad district.



The unconfined aquifer in the district occurs within the depth range of 0 to 78m bgl. Aquifers II (Confined) occur within the depth range of 43 to136 m bgl and aquifer group III (confined II and confined III) occur within the range of 78 to 350 m bgl. The thickness of the unconfined aquifer

ranges from 24 to 78 m. Confined aquifer I ranges in thickness from 18 to 72 m whereas the thickness of the confined aquifer III and IV ranges from 15 to 101m.

Bore	Depth 1 (m)	Depth 2 (m)	Aquifer
Sanand	0	44	Aquifer I
Sanand	44	64	Aquitard I
Sanand	64	136	Aquifer II
Sanand	136	164	Aquitard II
Sanand	164	200	Aquifer III
Sanand	200	200	Aquiclude I
Sanand	200	200	Aquitard III
Sanand	200	200	Aquifer IV
Sanand	200	200	Basalt

Water Quality (Aquifer)

Statistical Analysis of Chemical Constituents (Shallow Aquifer), May 2017

Constituents	Minimum	Maximum
pH	2.10	9.40
TDS (mg/l)	360	43390
CO3 (mg/l)	12	36
HCO3 (mg/l)	37	1049
Cl (mg/l)	50	18400
NO3 (mg/l)	0.61	115
SO4 (mg/l)	2	5271
F (mg/l)	0.12	11.20
Alkalinity (mg/l)	77	2984
Ca (mg/l)	10	1000
Mg (mg/l)	3	1000
TH (mg/l)	88	7500
Na (mg/l)	49	9999
K (mg/l)	2.30	481.85
Fe (mg/l)	0.002	0.641

The shallow ground water in the district is generally alkaline with pH more than 7. The value of pH ranges between 2.10 & 9.40 in the district.

The Carbonate concentration in large parts of district varies between 12 mg/l to 36 mg/l. The Bicarbonate concentration in the district varies between 37 mg/l at Sitapur III to 1049 mg/l at Bagodara.

The Chloride concentration in the shallow alluvial aquifer varies between 50 mg/l (Endla) and 18400 mg/l (Fedra). At 40 monitoring stations, Chloride concentration was more 50 than 1000 mg/l which is beyond maximum desirable limit of 1000 mg/l as per Indian norms.

Nitrate concentration in the ground water in the district varies between 0.61 mg/l (Sanand) and 115 mg/l (Tagadi).

The Calcium concentration in the district varies between 10mg/l (Gangad) and 1000 mg/l at Bhurakhi, Loliya, Nanibaru. The concentration of calcium is more than maximum permissible limits of 200 mg/l (as per BIS norms) at some location.

The Fluoride concentration in ground water varies between almost 0.12 at Raika and 11.20 mg/l at Kumarkhan. High concentration of fluoride exceeding maximum desirable limit of 1(mg/l) is found at some sampling points.

Without appropriate hydrology, other important factors, such as pH, organic matter, species selection, microtopography, soil compaction, and subsoil conditions on their own or in combination are not enough to sustain wetlands (source)

A.4. Rainfall and Hydrometeorology

The climate of the district is characterized by hot summer and general dryness except during the southwest monsoon seasons. The year can be divided into four seasons. The period from March to May is the hot season (summer) followed by southwest monsoon from June to September October and November constitute the post monsoon or retreating monsoon season. The cold season (winter) starts from December and ends in February.

The mean maximum temperature ranges between 28.4ºC during January to 41.8ºC during May and the mean minimum temperatures vary between 11.7ºC during January and 27ºC during June. The relative humidity varies between 32 % (March) and 79% (August). The wind velocity varies from 74 km/d (November) and 174.2 km/d (June). ***The potential Evapo-transpiration varies between 3.2 mm (December) and 7.8 mm/d (June).***

Long-term average annual rainfall recorded by IMD station at Ahmedabad is 799.6 mm. Most of the rainfall (about 766 mm) is received from south-west monsoon between June to September.

The PP has created channels for storm water drainage along the cycle tracks and planters via a 1000mm x 1500mm underground storm water channel on the road edges after the driveway & cycle lane. These storm water channels have precast drain covers with gratings flushed at the road level. The storm water drains are facilitating the collection of rainwater run-off from the hardscape areas (roads, pedestrian pathways). The slope of storm water drain is directed from the far ends of the SEZ towards the main gate, where it meets the city storm drain at the main road.

The overflow of run-off from these storm water drains are also diverted to the artificial reservoirs created at the SEZ. The PP has deliberately left many plots to create artificial reservoirs to recharge rainwater through natural percolation. On all these vacant plots, the PP has made several artificial recharge pits for retaining rainwater in the premises. These recharge pits now function as good as any natural lake and attracts various species of migratory birds. These lakes act as natural habitat and ornithologists and enthusiastic birdwatchers from across the state are invited to glance at these birds. The PP realizes that rainwater harvesting with gainful end use is just a small part of this big biodiversity ecosystem and takes upon itself to take such initiatives for restoration of declining migratory bird species.

State Emergency Operation Centre,Revenue Department, Gandhinagar

Rainfall Report 31/10/2015 (Rainfall in mm)

Sr. No.	Dist.	Avrg Rain (1985-2014)	Rains till Yester day	Rain During last 24 Hrs.	Total Rain fall	% Against Avrg Rain	Sr. No.	Dist.	Avrg Rain (1985-2014)	Rains till Yester day	Rain During last 24 Hrs.	Total Rain fall	% Against Avrg Rain
1	2	3	4	5	6	7	1	2	3	4	5	6	7
	KUTCH							East-CENTRAL GUJARAT					
1	Kutch						1	Ahmedabad					
1	Abdasa	377	259	0	259	68.76	1	Abad City	776	615	0	615	79.20
2	Anjar	398	899	0	899	225.86	2	Bavla	701	382	0	382	54.51
3	Bhachau	402	684	0	684	170.07	3	Dascroi	677	302	0	302	44.61
4	Bhuj	346	591	0	591	170.96	4	Detroj	645	515	0	515	79.79
5	Gandhidham	418	450	0	450	107.76	5	Dhandhuka	708	477	0	477	67.41
6	Lakhpat	335	434	0	434	129.70	6	Dholera	411	518	0	518	126.03
7	Mandvi(K)	410	406	0	406	98.96	7	Dholka	769	310	0	310	40.33
8	Mundra	469	288	0	288	61.47	8	Mandal	548	358	0	358	65.38
9	Nakhatrana	385	649	0	649	168.77	9	Sanand	759	701	0	701	92.33
10	Rapar	413	646	0	646	156.28	10	Viramgam	683	403	0	403	58.98
	Dist. Avrg	387	531	0	531	137.11		Dist. Avrg	648	458	0	458	70.69
	KUTCH REGION	387	531	0	531	137.11							

State Emergency Operation Centre,Revenue Department, Gandhinagar

Rainfall Report 19/10/2016 (Rainfall in mm)

Sr.No.	District/ Taluka	Avg Rain (1986-2015)	Rains till Yesterday	Rain During last 24 Hrs.	Total Rainfall	% Against Avg Rain	Sr. No.	District/ Taluka	Avg Rain (1986-2015)	Rains till Yesterday	Rain During last 24 Hrs.	Total Rainfall	% Against Avg Rain
1	2	3	4	5	6	7.00	1	2	3	4	5	6	7.00
	East-CENTRAL GUJARAT							East-CENTRAL GUJARAT					
8	Ahmedabad						12	Chhota Udepur					
1	Abad City	777	574	0	574	73.84	1	Bodeli	1074	1051	0	1051	97.86
2	Bavla	701	453	0	453	64.64	2	Chhota Udepur	900	881	0	881	97.92
3	Dascroi	681	416	0	416	61.10	3	Jetpur Pavi	1031	943	0	943	91.50
4	Detroj	645	337	0	337	52.21	4	Naswadi	933	607	0	607	65.08
5	Dhandhuka	704	514	0	514	72.97	5	Quant	928	762	0	762	82.14
6	Dholera	411	442	0	442	107.54	6	Sankheda	1225	764	0	764	62.35
7	Dholka	777	381	0	381	49.05		Dist. Avrg	1013	835	0	835	82.36
8	Mandal	548	270	0	270	49.31	13	Panchmahal					
9	Sanand	772	524	0	524	67.89	1	Ghoghamba	886	780	0	780	88.01
10	Viramgam	688	277	0	277	40.24	2	Godhra	844	911	0	911	107.93
	Dist. Avrg	670	419	0	419	62.47	3	Halol	1035	828	0	828	79.96

State Emergency Operation Centre,Revenue Department, Gandhinagar
Rainfall Report 03/11/2017 (Rainfall in mm)

Sr.No.	District/ Taluka	Avg Rain (1987-2016)	Rains till Yesterday	Rain During last 24 Hrs.	Total Rainfall	% Against Avg Rain	Sr. No.	District/ Taluka	Avg Rain (1987-2017)	Rains till Yesterday	Rain During last 24 Hrs.	Total Rainfall	% Against Avg Rain
1	2	3	4	5	6	7.00	1	2	3	4	5	6	7.00
	East-CENTRAL GUJARAT							East-CENTRAL GUJARAT					
8	Ahmedabad						12	Chhota Udepur					
1	Abad City	776	1049	0	1049	135.18	1	Bodeli	1221	990	0	990	81.06
2	Bavla	704	1024	0	1024	145.42	2	Chhota Udepur	902	916	0	916	101.55
3	Dascroi	671	647	0	647	96.49	3	Jetpur Pavi	1029	836	0	836	81.28
4	Detroj	644	644	0	644	100.06	4	Naswadi	921	557	0	557	60.50
5	Dhandhuka	698	728	0	728	104.23	5	Quant	950	615	0	615	64.72
6	Dholera	689	555	0	555	80.60	6	Sankheda	1211	1096	0	1096	90.48
7	Dholka	764	491	0	491	64.28		Dist. Avg.	1012	835	0	835	82.54
8	Mandal	581	468	0	468	80.59	13	Panchmahal					
9	Sanand	778	1007	0	1007	129.45	1	Ghoghamba	867	620	0	620	71.54
10	Viramgam	674	594	0	594	88.13	2	Godhra	858	997	0	997	116.24
	Dist. Avg.	699	721	0	721	103.15	3	Halol	1023	1014	0	1014	99.08

State Emergency Operation Centre,Revenue Department, Gandhinagar
Rainfall Report 31/10/2018 (Rainfall in mm)

Sr.No.	District/ Taluka	Avg Rain (1988-2017)	Rains till Yesterday	Rain During last 24 Hrs.	Total Rainfall	% Against Avg Rain	Sr. No.	District/ Taluka	Avg Rain (1988-2017)	Rains till Yesterday	Rain During last 24 Hrs.	Total Rainfall	% Against Avg Rain
1	2	3	4	5	6	7	1	2	3	4	5	6	7
	East-CENTRAL GUJARAT							East-CENTRAL GUJARAT					
8	Ahmedabad						12	Chhota Udepur					
1	Abad City	803	418	0	418	52.04	1	Bodeli	1240	656	0	656	52.89
2	Bavla	725	377	0	377	52.00	2	Chhota Udepur	910	938	0	938	103.03
3	Dascroi	685	245	0	245	35.74	3	Jetpur Pavi	1041	880	0	880	84.54
4	Detroj	660	233	0	233	35.28	4	Naswadi	923	559	0	559	60.55
5	Dhandhuka	717	395	0	395	55.11	5	Quant	949	701	0	701	73.90
6	Dholera	701	366	0	366	52.20	6	Sankheda	1234	810	0	810	65.65
7	Dholka	767	292	0	292	38.07		Dist. Avg.	1050	757	0	757	72.13
8	Mandal	592	113	0	113	19.10	13	Panchmahal					
9	Sanand	805	304	0	304	37.78	1	Ghoghamba	873	637	0	637	72.95
10	Viramgam	689	173	0	173	25.10	2	Godhra	876	979	0	979	111.82
	Dist. Avg.	714	292	0	292	40.84	3	Halol	1044	901	0	901	86.27

State Emergency Operation Centre, Revenue Department, Gandhinagar
Rainfall Report 30/11/2019 (Rainfall in mm)

Sr.No.	District/ Taluka	Avrg Rain (1989-2018)	Rain till Yesterday	Rain During last 24 Hrs.	Total Rainfall	% Against Avg Rain	Sr. No.	District/ Taluka	Avrg Rain (1989-2018)	Rain till Yesterday	Rain During last 24 Hrs.	Total Rainfall	% Against Avg Rain
1	2	3	4	5	6	7	1	2	3	4	5	6	7
	East-CENTRAL GUJARAT							East-CENTRAL GUJARAT					
8	Ahmedabad						12	Chhota Udepur					
1	Abad City	793	852	0	852	107.45	1	Bodeli	1222	1576	0	1576	128.93
2	Bavla	696	965	0	965	138.74	2	Chhota Udepur	899	2485	0	2485	276.38
3	Dascroi	668	726	0	726	108.72	3	Jetpur Pavi	1043	1492	0	1492	143.01
4	Detroj	634	496	0	496	78.18	4	Naswadi	915	1423	0	1423	155.50
5	Dhandhuka	699	1095	0	1095	156.72	5	Quant	929	2445	0	2445	263.07
6	Dholera	682	762	0	762	111.71	6	Sankheda	1221	1350	0	1350	110.56
7	Dholka	735	935	0	935	127.27		Dist. Avg.	1014	1795	0	1795	177.09
8	Mandal	562	441	0	441	78.52	13	Panchmahal					
9	Sanand	795	957	0	957	120.42	1	Ghoghamba	858	1026	0	1026	119.52
10	Viramgam	661	498	0	498	75.32	2	Godhra	878	1199	0	1199	136.57
	Dist. Avg.	695	773	0	773	111.12	3	Halol	1044	1664	0	1664	159.44

8 - RAINFALL REPORT-ZONEWISE

Rainfall Report 10-11-2020 (Rainfall in mm)

Sr.No.	District/ Taluka	Avrg Rain (1990-2019)	Rain till Yesterday	Rain During last 24 Hrs.	Total Rainfall	% Against Avg Rain	Sr. No.	District/ Taluka	Avrg Rain (1990-2019)	Rain till Yesterday	Rain During last 24 Hrs.	Total Rainfall	% Against Avg Rain
1	2	3	4	5	6	7	1	2	3	4	5	6	7
	East-CENTRAL GUJARAT							East-CENTRAL GUJARAT					
8	Ahmedabad						12	Chhota Udepur					
1	Abad City	798	925	0	925	115.94	1	Bodeli	1238	1103	0	1103	89.08
2	Bavla	704	560	0	560	79.58	2	Chhota Udepur	944	1161	0	1161	122.93
3	Dascroi	668	514	0	514	76.96	3	Jetpur Pavi	1074	1302	0	1302	121.28
4	Detroj	634	489	0	489	77.09	4	Naswadi	931	878	0	878	94.30
5	Dhandhuka	712	801	0	801	112.49	5	Quant	973	966	0	966	99.24
6	Dholera	684	683	0	683	99.80	6	Sankheda	1229	946	0	946	76.95
7	Dholka	742	817	0	817	110.14		Dist. Avg.	1042	1059	0	1059	101.64
8	Mandal	560	445	0	445	79.51	13	Panchmahal					
9	Sanand	805	915	0	915	113.74	1	Ghoghamba	865	921	0	921	106.54
10	Viramgam	661	616	0	616	93.18	2	Godhra	878	836	0	836	95.20
	Dist. Avg.	699	677	0	677	96.80	3	Halol	1067	1456	0	1456	136.41

8 - RAINFALL REPORT-ZONEWISE

Rainfall Report 30-11-2021 (Rainfall in mm)

Sr.No.	District/ Taluka	Avrg Rain (1991-2020)	Rain till Yesterday	Rain During last 24 Hrs.	Total Rainfall	% Against Avg Rain	Sr. No.	District/ Taluka	Avrg Rain (1991-2020)	Rain till Yesterday	Rain During last 24 Hrs.	Total Rainfall	% Against Avg Rain
1	2	3	4	5	6	7	1	2	3	4	5	6	7
	East-CENTRAL GUJARAT							East-CENTRAL GUJARAT					
8	Ahmedabad						12	Chhota Udepur					
1	Abad City	795	561	0	561	70.56	1	Bodeli	1219	1023	0	1023	83.95
2	Bavla	689	424	0	424	61.56	2	Chhota Udepur	943	1431	0	1431	151.76
3	Dascroi	651	558	0	558	85.75	3	Jetpur Pavi	1064	1086	0	1086	102.05
4	Detroj	612	381	0	381	62.29	4	Naswadi	912	850	0	850	93.17
5	Dhandhuka	715	619	0	619	86.56	5	Quant	965	1290	0	1290	133.62
6	Dholera	684	738	0	738	107.97	6	Sankheda	1205	845	0	845	70.15
7	Dholka	735	669	0	669	90.96		Dist. Avg.	1028	1088	0	1088	105.76
8	Mandal	536	359	0	359	67.04	13	Panchmahal					
9	Sanand	805	641	0	641	79.58	1	Ghoghamba	848	488	0	488	57.53
10	Viramgam	643	365	0	365	56.79	2	Godhra	854	806	0	806	94.33
	Dist. Avg.	689	532	0	532	77.12	3	Halol	1067	942	0	942	88.26

8 - RAINFALL REPORT-ZONEWISE

Rainfall Report 30-11-2022 (Rainfall in mm)(Dt.29-11.2022 06:00 am to Dt.30.11.2022 06:00 am)

Sr.No.	District/ Taluka	Avrg Rain (1992-2021)	Rain till Yesterday	Rain During last 24 Hrs.	Total Rainfall	% Against Avg Rain	Sr. No.	District/ Taluka	Avrg Rain (1992-2021)	Rain till Yesterday	Rain During last 24 Hrs.	Total Rainfall	% Against Avg Rain
1	2	3	4	5	6	7	1	2	3	4	5	6	7
	East-CENTRAL GUJARAT							East-CENTRAL GUJARAT					
8	Ahmedabad						12	Chhota Udepur					
1	Abad City	796	1009	0	1009	126.80	1	Bodeli	1219	1408	0	1408	115.52
2	Bavla	688	433	0	433	62.98	2	Chhota Udepur	968	1041	0	1041	107.57
3	Dascroi	643	519	0	519	80.72	3	Jetpur Pavi	1055	1192	0	1192	113.01
4	Detroj	600	340	0	340	56.69	4	Naswadi	917	810	0	810	88.33
5	Dhandhuka	724	750	0	750	103.53	5	Quant	985	1418	0	1418	143.89
6	Dholera	697	585	0	585	83.96	6	Sankheda	1199	1201	0	1201	100.18
7	Dholka	742	631	0	631	84.99		Dist. Avg.	1033	1178	0	1178	114.07
8	Mandal	523	437	0	437	83.56	13	Panchmahal					
9	Sanand	806	467	0	467	57.95	1	Ghoghamba	844	540	0	540	64.01
10	Viramgam	630	341	0	341	54.10	2	Godhra	859	1000	0	1000	116.40
	Dist. Avg.	687	551	0	551	80.18	3	Halol	1065	939	0	939	88.13

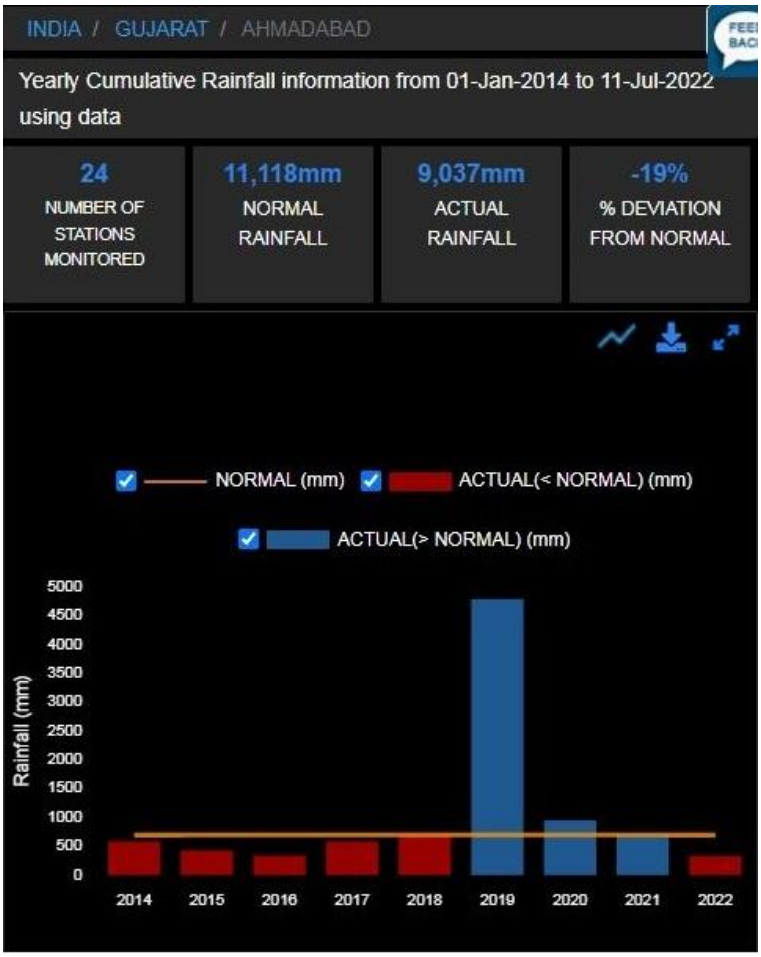
8 - RAINFALL REPORT-ZONEWISE

Rainfall Report 29-11-2023 (Rainfall in mm)(Dt.28.11.2023 06:00 am to Dt.29.11.2023 06:00 am)

Sr.No.	District/ Taluka	Avrg Rain (1993-2022)	Rain till Yesterday	Rain During last 24 Hrs.	Total Rainfall	% Against Avg Rain	Sr. No.	District/ Taluka	Avrg Rain (1993-2022)	Rain till Yesterday	Rain During last 24 Hrs.	Total Rainfall	% Against Avg Rain
1	2	3	4	5	6	7	1	2	3	4	5	6	7
	East-CENTRAL GUJARAT							East-CENTRAL GUJARAT					
8	Ahmedabad						12	Chhota Udepur					
1	Ahmedabad City	810	836	0	836	103.17	1	Bodeli	1228	1147	0	1147	93.40
2	Bavla	685	345	0	345	50.35	2	Chhota Udepur	974	1369	0	1369	140.54
3	Daskroi	645	451	0	451	69.90	3	Jetpur Pavi	1068	1183	0	1183	110.77
4	Detroj-rampura	596	326	0	326	54.69	4	Nasvadi	921	627	0	627	68.08
5	Dhandhuka	723	904	0	904	125.01	5	Kavant	1004	934	0	934	93.03
6	Dholera	690	721	0	721	104.49	6	Sankheda	1201	1135	0	1135	94.49
7	Dholka	747	403	0	403	53.97		Dist. Avg.	1066	1066	0	1066	99.98
8	Mandal	522	409	0	409	78.29	13	Panchmahal					
9	Sanand	804	527	0	527	65.51	1	Ghoghamba	841	554	0	554	65.87
10	Viramgam	627	397	0	397	63.36	2	Godhra	864	1287	0	1287	148.97
	Dist. Avg.	685	532	0	532	77.65	3	Halol	1072	937	0	937	87.44

Year/Rainfall (mm)	Ahmedabad	Sanand
2015	615	701
2016	574	524
2017	1049	1007
2018	418	304
2019	852	957
2020	925	915
2021	561	641
2022	1009	467
2023	836	527

Source: Revenue Department, Gujarat



https://indiawris.gov.in/wris/#/rainfall

Yearly rainfall(in mm) trends for Ahemdabad from 01-Jan-2014 to 31-Dec-2022		
Dates	**NORMAL (mm)**	**ACTUAL (mm)**
2014	694.9	580.2
2015	694.9	422.25
2016	694.9	333.54
2017	694.9	579.16
2018	694.9	688.65
2019	694.9	4787.93
2020	694.9	947.96
2021	694.9	699.89
2022	694.9	330.21

Source: Indiawris.gov.in

A.5. Alternate methods to the Project Activity

The overall development in the district is 78.36 %, and as a whole the Ahmedabad district is in Semi Critical category. In the semi critical blocks the ground water may be developed along with rain water harvesting measures.

The suitable recharge structures feasible in the Ahmedabad district are percolation tanks/ponds, recharge wells, recharge shaft, check dams, nallah bunds etc. depending on the terrain conditions. In the phreatic aquifers with deep water levels and desaturation, spreading channels, recharge pits, recharge ponds etc. are suitable to utilize surplus runoff and tail end releases from the canals.

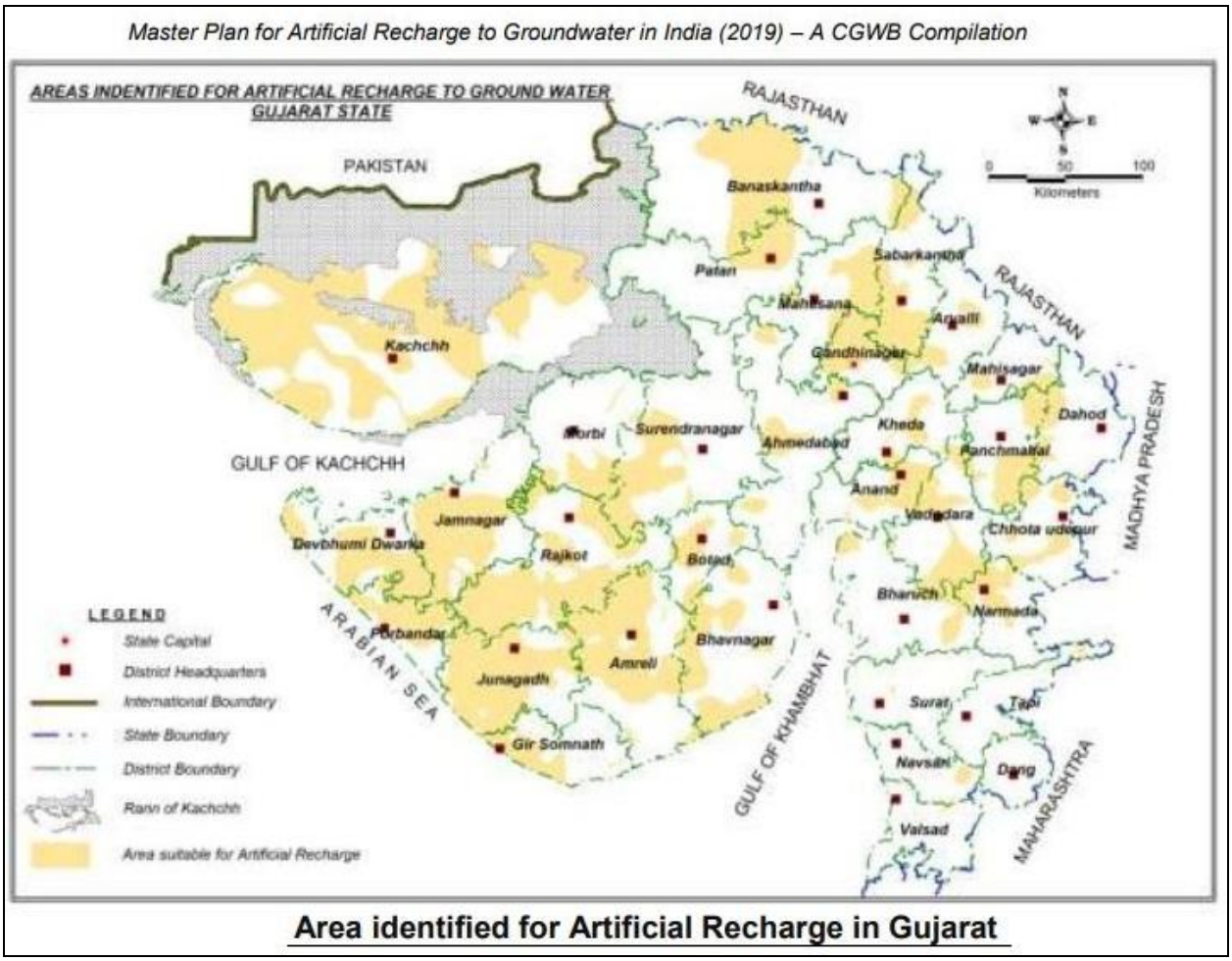
Source: Master Plan for Artificial Recharge to Groundwater in India (2020) – A CGWB Compilation

Traditional Artificial Recharge Practices in India

Region	Structure	Description	Areas
Kutch region of Gujarat,	Kundi	Looks like an upturned cup nestling in a saucer 10-12 m deep pits dug near tanks to collect the seepage water	Some parts of Gujarat
	Nadis Tobas Tanks Khadin Vav/Vavdi/ Bavoli/ Bavadi	Ponds storing water during rainy season Natural catchment with ground depression Lined circular holes made in the ground Built across the lower hill slopes Traditional step wells with a sluice constructed at the rim	Gujarat
	Virdas	Shallow wells in low depressions	Rann of Kutch, Gujarat
	Paar	A common water harvesting place, rain water flows from the catchment and percolates into the sandy soil	Rann of Kutch, Gujarat

In the confined aquifers artificial recharge by indirect injection technique is suitable that is dual purpose connector wells. These recharge wells should have screens against upper saturated

aquifer and also against the targeted confined aquifer. It would function under gravity since the piezometric level of confined aquifer is much below phreatic water level.



Area identified for Artificial Recharge in Gujarat

Scope of Artificial Recharge in Gujarat

S.No	District	Area of District (Sq.Km.)	Area Identified for AR (Sq.Km.)	Volume of Unsaturated Zone (MCM)	Available Subsurface Space for AR (MCM)	Water Required for Recharge (MCM)	Surplus Available for Recharge (MCM)
1	Ahmedabad	7018.65	751.13	2901.69	435.25	578.88	15.00

Various rainwater harvesting schemes depending on the suitable hydro geological conditions have been constructed in the district viz. check dams, recharge tube wells , deepening of the village ponds etc. and have shown good impact on the groundwater scenario.

Extract of ENVIS newsletter on 'Status of water environment in Gujarat' highlights that in Ahmedabad district, ground water level was 63 m in 1997, and it went to 100 m in 2011. Among other districts, **Ahmedabad has shifted to semi critical from over exploited zone over last decade**.

However, Gujarat has seen a record number of construction of groundwater recharge structures within the state during the last decade and this has resulted in additional water harvesting ultimately leading to rise in groundwater levels in the current decade.

A.6. Design Specifications

The Ramsar Convention defines - "Wetlands are areas of marsh, fen, peat-land or water, whether natural or artificial, fresh, brackish or salty, including area of marine water, the depth of which at low tides does not exceed six meters*."(Source: RAMSAR Convention, Art 1.1 and 2,1).*

Wetlands also represents land transitional between terrestrial and aquatic eco-systems where the water table is usually at or near the surface or the land is covered by shallow water (as in the case of the project activity).

In natural wetlands, biological processes occur in which many pollutants are degraded. This degradation is facilitated by the aerobic and anaerobic conditions of the wetlands and is a very effective remediation solution.

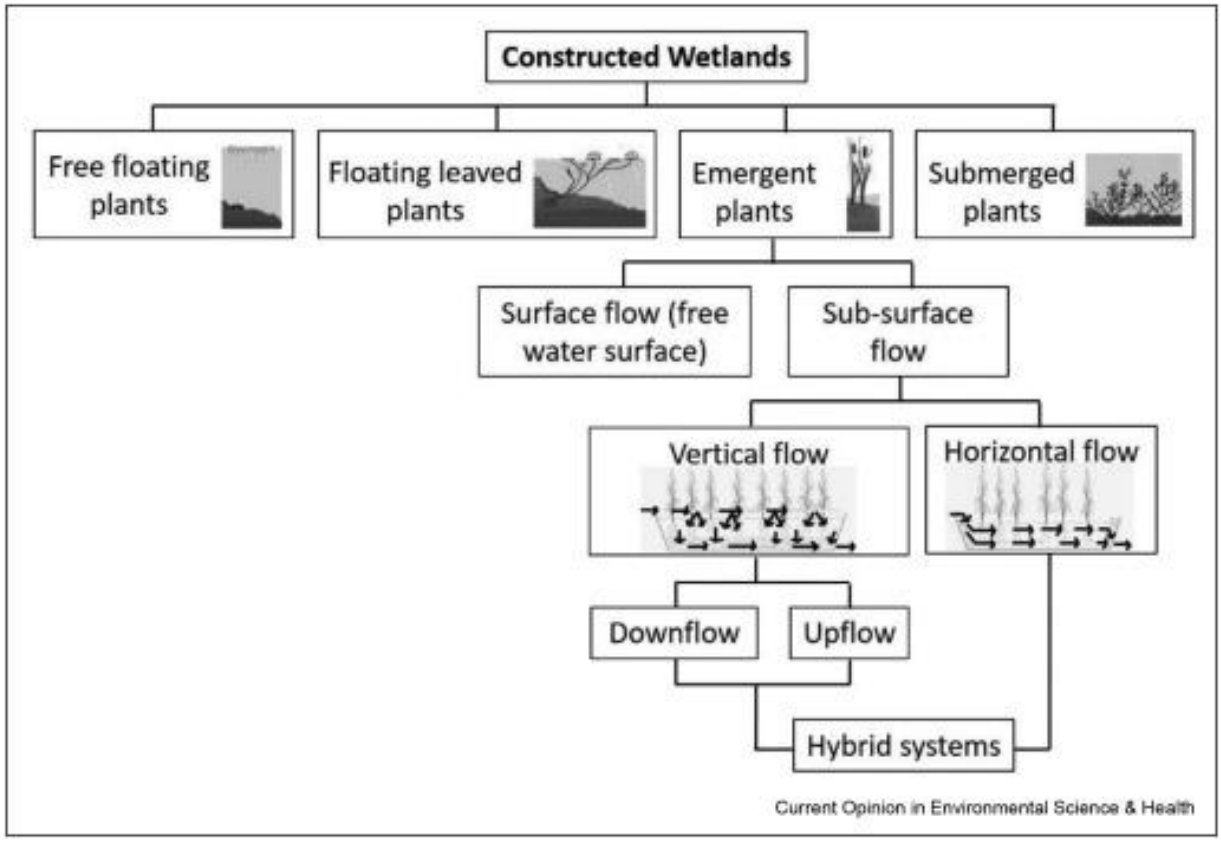
The wetland in the project activity is classified as ***palustrine (isolated***) type of wetland.

Similarly, the constructed (man-made) wetlands approach by the PP imitates these capabilities, making natural decomposition suitable for various types of waterborne contaminants. There are many benefits to using constructed wetlands for remediation including:

- They are very energy efficient
- They use biological processes to degrade contaminants
- They can be fully integrated into sensitive areas
- They are an affordable option with low maintenance costs
- They have less impact on the environment

As in the case of natural wetlands, there is no single global classification for constructed wetlands, but their categorization is more straightforward and is based on
(i) type of vegetation growth (i.e., free-floating, floating-leaved, emergent, submergent), and
(ii) water flow regime (surface, subsurface) and flow direction (horizontal, vertical)

Constructed wetlands are usually characterized by a relatively simple design and great scalability and flexibility.



As regards the overall capacity of water body, the total catchment area covered by the wetland is 48 hectares. Since it is a large area, the overall capacity is estimated based on the approximate depth for dug-out water bodies as 4 feet. The PP has ensured that in every phase of development some plots within the SEZ are filled with water for birds and also to recharge groundwater. The SEZ has made several artificial recharge pits for retaining rainwater in some of the plots in the premises. These recharge pits now function as good as any natural lake and attracts various species of migratory birds. These wetlands act as natural habitat and ornithologists and enthusiastic birdwatchers from across the state routinely visit the site to observe these birds.
The PP realizes that such efforts help promote natural biodiversity and helps restore the declining rate of migratory bird species.

Of the total 114 hectares, approximately 48 hectares (i.e., 42% of plot area) has been left as low lying areas for rainfall accumulation for contributing to groundwater recharge.

Thus, there is a total increase of more than 100% of water bodies and hence complies with thresholds of increase in water bodies compared to base year since inception (2006).

The aquifers best suited for artificial recharge are those aquifers which absorb large quantities of water and do not release them too quickly. Theoretically this will imply that the vertical hydraulic conductivity is high, while the horizontal hydraulic conductivity is moderate. These

two conditions are not often encountered in nature, hence the construction of groundwater recharge wetlands (man-made wetlands) allows water to gradually percolate through the soil and recharge the aquifer within the project boundary.

Total Catchment Area (2014-2020)	497873 m^2
Total Catchment Area (2021-2023)	460808 m^2

Groundwater recharge wetland schematic

A.7. Implementation Benefits to Water Security and/or SDG Impact

The artificial recharge techniques by the PP inter relate land integrate the source water to ground water reservoir. Two effects are generated by artificial recharge in ground water reservoir namely –

(a) Rise in water level and

(b) Increment in the total volume of the ground water reservoir

The impact assessment of Artificial Wetland schemes can generally be enumerated as follows: -

1) Conservation and harvesting of surplus monsoon runoff in ground water reservoir which otherwise was going un-utilised outside the watershed/ basin and to sea.

2) The project activity promotes awareness of water birds and water bird conservation issues including the importance of wetlands.

3) Rise in ground water levels due to additional recharge to ground water. In case where continuous decline of ground water level was taking place, a check to this and/or the intensity of decline subsequently reduces. The energy consumption for lifting the water also reduces.

4) The ground water structures in the benefitted zone of artificial structures gains sustainability and the wells provides water in lean month when these were going dry. The domestic wells become sustainable and many of the areas become tanker free.

5) The cropping pattern in the benefitted zone will undergo marked change due to additionality of ground water and cash crops will start growing. Orchards which went dry earlier due to ground water scarcity may rehabilitated and new plantation be grown.

6) Green vegetation cover increases in the zone of benefit and also along the structures due to additional availability of soil moisture.

7) The quality of ground water improves due to dilution.

8) Besides the direct measurable impacts, the artificial recharge schemes generate indirect benefit in terms of decease in soil erosion, improvement in fauna and flora, influx of migratory birds, etc.

Since it is a large area, the overall capacity is estimated based on the approximate depth for dug-out water bodies as 4feet. Based on the above calculation (48 Hectares i.e, 51,66,677 sq.ft X 4 feet), the overall capacity of water bodies is 2,06,66,708 cubic feet (58.52 crore litres).

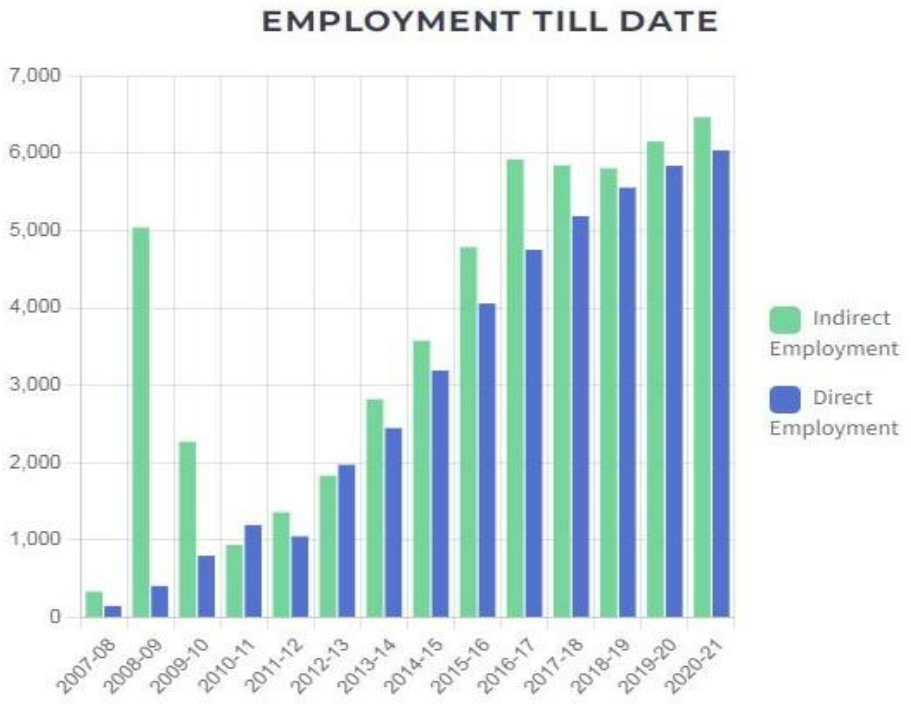
The water bodies enhances the microclimate and improves the ground water table till all the vacant plots are developed and sold. **As part of response narrative to protect & restore biodiversity around the artificial wetlands, the PP has planted an average of 1000-2000 tree saplings since 2015, apart from 2019 when 19,000 saplings were planted. Currently, the PP has planted a total of 28,500 trees and tree saplings, with 11,800 trees consisting of 21 native species within the SEZ.**

Several states in India are water stressed and 54% of India faces high to extremely high water stress and 54% of ground water wells are decreasing (source WRI). The report also says that there could be no ground water for irrigation by 2025 in Delhi, Rajasthan and Haryana. UNESCO Report says India holds the number 1 spot for the annual Ground water extraction at 251 cu.km as against 112 cu.km in China and USA, a distant second. Competing demands for water from agriculture and domestic use has limited industrial growth (source).

Sustainable Development Goals Targeted	Most relevant SDG Target/Impact	Indicator (SDG Indicator)
 13 Climate Action (mandatory)	13.2: Integrate climate change measures into national policies, strategies and planning	The project activity acts as carbon sinks. The wetlands act as storm surge buffers and provides erosion control.
 1 - End poverty in all its forms everywhere	1.4: By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance	The PP prevents unequal distribution of natural groundwater resources- which prevents poverty of natural economic resources (groundwater). The PP ensures that the citizens of Ahmedabad get a chance to preserve their natural groundwater resources for future generations since PP is recharging the groundwater.

 14- By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution	Conserve and sustainably use the oceans, seas and marine resources for sustainable development	The project activity helps stabilize the water cycle, carbon cycle and nutrient cycle which would otherwise be significantly altered. The wetlands are of critical importance to biodiversity and to the functioning of virtually all terrestrial and coastal ecosystems. The prolonged presence of water creates conditions that favor the growth of specially adapted plants (hydrophytes) and promote the development of characteristic wetland (hydric) soils.
 15- Life on Land	Protect, restore and promote sustainable use of terrestrial ecosystems, halt and reverse land degradation and halt biodiversity loss	The PP prevents global biodiversity loss
 11-Make cities and human settlements inclusive, safe, resilient and sustainable	11.A: Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning	The project activity acts as a natural sponge absorbing rainfall, providing protection against coastal and river flooding to (partially) offset the need for man-made infrastructure. The project activity also helps reduce and regulate sediment transport thereby contributing to land formation and coastal zone stability.

 **6**-Ensure access to water and sanitation for all	6.3: By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally	Wetlands such as the project activity ensures fresh water availability, helps replenish ground aquifers, and purifies and filters harmful waste from water – such as fertilizers and pesticides, as well heavy metals and toxins from industry. The PP has showcased harvesting and recharging **1305 million litres** of unutilized water during this monitored period.
 17 – Strengthen the means of implementation and revitalize the global partnership for sustainable development	17.7: Promote the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries on favourable terms including on concessional and preferential terms, as mutually agreed	PP will monetize the water credits via the virtual water footprint market internationally.



Employment data within the entire SEZ

Decades of misuse, poor management, over extraction of groundwater and contamination of freshwater supplies have exacerbated water stress worldwide. In addition, countries are facing growing challenges linked to degraded water-related ecosystems, water scarcity caused by climate change, underinvestment in water and sanitation and insufficient cooperation on trans boundary waters.

The project activity also encourages companies, especially large and transnational companies in the biotechnology and biopharmaceuticals sector, to adopt similar sustainable practices in regards to captive water requirements and groundwater management.

A.7.1 Objectives or Outcomes

The impact assessment or objectives of this project activity can generally be enumerated as follows:

- The project activity highlights the catalytic role that corporate India must play in securing future water resources through nature based groundwater management.
- The PP showcases efficient methods to replenish depleted groundwater supplies as a key corporate environmental intervention towards a more water secure India
- The PP has showcased an increase of over 10% in the groundwater table within the project boundary due to the project activity (with 2010 as base year for reference).
- The PP has created a Bird Census (2021), highlighting the success of the wetland project in attracting birds, complete with a map of bird sighting locations, birds list along with bird photographs.
- The PP maintains the wetland with a view to ensure sufficient water exists to maintain the desired level of their ecological health which is demonstrated by the biodiversity within the project boundary.
- The project activity showcases the intrinsic value of biological diversity, as well as the ecological, scientific, educational, cultural, recreational and aesthetic value of biological diversity and its critical role in maintaining ecosystems that provide essential services, which are critical foundations for sustainable development and human well-being.

BIRDS LIST

Nos.	Bird's Name	Gujarati Name	Abbreviations
1	Black Drongo	કાળીયો કોશી	Resident
2	Black Ibis	કાળી કાંકણસાર	Resident
3	Black Kite	સમડી	Local
4	Black Tailed Godwit	મોટો ગોડેરો	Migratory
5	Black winged Stilt	ગજપાઉ	Local Migratory
6	Comb Duck	નકટો	Local Migratory
7	Common Babbler	લેલેડુ	Resident
8	Common Coot	ભગતડુ	Local Migratory
9	Common Moorhen	જલમમુરઘો	Local Migratory
10	Common Redshank	રાતાપગ	Migratory
11	Common Teal	નાની મરઘાબી	Local Migratory
12	Crow Pheasant	કુકડિયો કુભાર	Resident
13	Gadwall	ગુહાર બતક	Migratory
14	Garganey	ચેતવા	Migratory
15*	Grey Francolin	તેતર	Resident
16	Grey Heron	કબત બગલો	Resident
17	Greater Egret	વચેટ ધોળો બગલો	Resident
18 *	Greater Flamingo	મોટો હંજ	Migratory
19 *	Greater White Pelican	ગુલાબી પેઢ	Migratory
20	Green Bee-eater	નાનો પતરંગો	Resident
21	Greylag Goose	ગાજ હંસ	Local Migratory
22	Honey Buzzard	મધિયો બાજ	Resident
23	Indian Roller	નીલકંઠ	Resident
24 *	Lesser Whistling Duck	નાની સિસોટી બતક	Resident
25	Little Cormorant	નાનો કજિયો	Resident
26	Little Egret	નાનો ધોળો બગલો	Resident
27	Little Grebe	નાની ડુબકી	Local Migratory
28	Marsh Harrier	પાન પકાઈ	Migratory
29	Night Heron	રાત બગલો	Resident
30	Northern Pintail	સીગપર	Migratory
31	Northern Shoveller	ગયણો	Migratory
32	Painted Stork	પીળીચાંચ હોક	Local Migratory
33	Pied King Fisher	કબરો કલકલિયો	Local Migratory

Bird census (2021) to showcase biodiversity

34	Pond Heron	કાળી બગલી	Local Migratory
35	Purple Swamphen	નીલ જલમરઘો	Resident
36	Red-wattled Lapwing	ટિટોડી	Resident
37 *	River Tern	કેચીપૂછ ચમચગલી	Resident
38*	Sarus Crane	સારસ	Resident
39	Spot-billed Duck	ટીલીયાળી બતક	Migratory
40	Sunbird	શક્કરખોરો	Resident
41	White Breasted Waterhen	સફેદ છાતી સેતાડકડી	Resident
42	White Ibis	સફેદ કાકણસાર	Resident
43	White throated King Fisher	કલકલિયો	Resident
44	White Wagtail	ધોબીડો	Local Migratory
45	Yellow Wagtail	રાખોડીશિર પીળકિયો	Local Migratory

* Observed for the 1st Time at project site

Bird census (2021) to showcase biodiversity

Birds Photographs

Black Drongo 	Black Ibis 	Black Kite 
Black Tailed Godwit 	Black winged Stilt 	Comb Duck 
Common Babbler 	Common Coot 	Common Moorhen 
Common Redshank 	Common Teal 	Crow Pheasant 
Gadwall 	Garganey 	Grey Francolin 

Grey Heron 	Greater Egret 	Greater Flamingo 
Greater White Pelican 	Green Bee-eater 	Grey lag Goose 
Honey Buzzard 	Indian Roller 	Lesser Whistling Duck 
Little Cormorant 	Little Egret 	Little Grebe 
Marsh Harrier 	Night Heron 	Northern Pintail 

Northern Shoveler 	Painted Stork 	Pied King Fisher 
Pond Heron 	Purple Swamphen 	Red-wattled Lapwing 
River Tern 	Sarus Crane 	Spot-billed Duck 
Sunbird 	White Breasted Waterhen 	White Ibis 
White throated KingFisher 	White Wagtail 	Yellow Wagtail 

(Source: Bird Survey by PP 2021)

A.7.2 Interventions by Project Owner / Proponent / UWR Member

The PP has planned artificial recharge as an effective method to increase of groundwater levels within the project boundary prior to the wetlands being sold and converted for their designated use (i.e. industrial units within the SEZ).

In India, Gujarat is considered as wetland rich state. In fact, from the view-point of extent of the wetlands, Gujarat is number one state as its wetland area contributes unmatchable 23% of wetland area of the country.

Space Applications Center (SAC-ISRO) has estimated total wetland area of 34,749.50 sq. km in Gujarat state in its "National Wetland Atlas-Gujarat" (2010). It accounts for about 17.56% of geographical area of the state. The coastal wetlands dominate in the state, of which the major wetland types include intertidal mud flat (22,603.65 sq. km.), creek (1,498.98 sq. km) and salt marsh (1,442.68sq.km). Among inland wetlands river/stream (2,758.77 sq.km), and reservoir/barrage (2,489.79 sq.km) are the major wetlands in the state. Some of the unique wetlands like corals and mangrove are found in Gujarat state.

As per SAC's "National Wetland Atlas-Gujarat" there are a total of 14,183 wetlands with minimum 2.25 ha each in Gujarat. Out of these 14,183 wetlands 1,358 wetlands (i.e., 9.57%) are inland natural wetlands covering 3200 sq.km, whereas 10,075 wetlands (71.035%) are inland man-made covering 3400 sq. km. As far as coastal wetlands are concerned, 2,448 wetlands (i.e., 17.26%) are natural wetlands covering 27100 sq. km area, whereas 302 (2.12%) wetlands are man-made wetlands covering 1000 sq.km of the State.

There are eight wetlands in Gujarat that are declared as Nationally Important Wetlands by Government of India.

The PP has established a constructed wetland which is an engineered sequence of water bodies designed to collect rainwater runoff. Constructed wetlands are one example of nature-based solutions.

Increase in population density and improvement in quality of life has resulted in an increase in demand of natural resources like water. Groundwater being the major source of water supply catering to about 85% of rural water supply, the stress on groundwater is ever increasing. It has resulted in over-exploitation of the resources at places. The situation demands for a reorientation of the strategy for its development and management.

The intervention of the PP has had a direct impact on the water security of the area. Over-development of the ground water resources results in declining ground water levels, shortage in water supply, intrusion of saline water in coastal areas and increased pumping lifts necessitating deepening of ground water structures and increase in power costs.

A.8. Feasibility Evaluation

The basic requirements for groundwater recharge wetlands are:

a) Availability of non-committed surplus monsoon run off in space and time.

b) Identification of suitable hydrogeological environment and sites for creating subsurface reservoir through cost effective artificial recharge techniques.

The measures for water conservation undertaken by the PP has already showcased an increase in the groundwater table within the project boundary.

A.9. Ecological Aspects:

The project activity is important for supporting a habitat suitable for wetland birds. The PP has conducted a bird survey that provides data on the birds at the wetland and also the health of the wetland; since a good number of water birds indicates that it has adequate feeding, roosting, and foraging spots/sites.

Gujarat is host to India`s most important bird wintering ground. It has a variety of habitats including the saline desert wilderness of the Great and Little Rann of Kutch, the arid grasslands and scrub of Banni in Kutch and the Kathiawad Peninsula (Saurashtra); a 1666 km long coastline with Marine National Park, the dry deciduous forests of Gir and Barda Hills, the moist deciduous forests of South Gujarat, and mountain ranges like the Aravallis of North Gujarat, the Satpura and Vindhya hills of Eastern Gujarat and the Sahyadhris of South Gujarat.

This geographic diversity and the state's location on the migration route of many birds heading south from the Palearctic ensure that visitors to the state return with an impressive list (approximately 500 species are found in Gujarat) of bird sightings.

The wetland project by the PP is within the arid regions of the state which attract an immense variety of birds in large flocks during the winter months when migration is at its peak. Gujarat is also the breeding area of many birds including endangered species like the Lesser Florican and Great Indian Bustard that nest in the grasslands.

Large heronries can be seen at the Marine National Park and along the Bhavnagar District coastline. In addition, Kutch District is amazing for desert and wetland birding, Sasan Gir forest is also interesting for birders. The Union Territory of Diu, an island offshore from Gujarat, has a Bird Sanctuary that is good for coastal bird watching. Every January, scores of bird enthusiasts from different parts of the Asia-Pacific region flock to estuaries, rivers, lakes, tidal mudflats and man-made wetlands, like the one maintained by the PP.

Wetland-dependent birds such as egrets, ibises, cranes, geese, ducks, herons and storks make pit-stops at these habitats on their long flight to escape the bitter winter in their breeding grounds of Siberia and northern Asia.

The Gujarat Forest Department here carried out an estimation of wetland birds at district level, to have in their possession an authenticated database of water bird species for their future conservation and management.

The project activity also encourages companies, especially large and transnational companies in the biotechnology and pharmaceuticals sector, to adopt similar sustainable practices in regards to captive water requirements and groundwater management.

Ecological Issues addressed by the project activity in terms of	
Inundation of habitated land	**None.** The project does not lead to inundation of residential land. The wetland is built over vacant industrial land within a SEZ.
Creation of water logging and vector disease prevention mitigation	**None.** Wetlands are cost-effective flood-mitigation measures. The project activity is a man-made freshwater wetland without any urban waste discharge namely sewage, sullage and garbage from the surrounding industries. Hence the occurrence of vector borne diseases is prevented.
Deterioration of quality of groundwater	**None.** Groundwater recharge is one of the most important functions of wetlands. Water that infiltrates and recharges groundwater contributes to the local and regional groundwater flow net, thus contributing to higher base flows and improved distribution of seasonal flows. The quality of the groundwater is improved by dilution with rainwater runoff (freshwater).

A.10. Recharge Aspects :

Hydro geological setup indicates that alluvium forms a slightly better potential aquifer within the project boundary and surrounding areas. Number of individual bore wells is yielding in house and used for domestic purpose, same as in cultivated land also. In the studied area Narmada irrigation canal water supply system spread all over the area. As the slope is low, runoff becomes less and as a result the seep rate increases as per flat topographical condition of the area, water seeps through top brown yellow clay mixed sandy soil with few silt, below that kankar concentration /yellow sticky non permeable clay/silt with gravel/ sand at depth below ground level and lowering of casing (blind & slotted) up to drilled depth.

As per collected inventory quality of ground water is good at Kavitha, Moraiya & Chacharvadi Vasna; while slightly saline at Changodar, Modasar, Moti Devti, Bhat, Bavla, Sanand, Pipan & villagers are using it for domestic utilization. At Bavla, Sanand & Piapan bore well water gets mixed with Narmada water pipe line in underground/overhead tank before it is supplied to village.

A.10.1 Solving for Recharge

Sources of hydrological flows into wetlands are predominately precipitation, surface water, and ground water. Water flows out of wetlands by **evapotranspiration, surface runoff, and sub-surface water outflow**. Hydrodynamics (the movement of water through and from a wetland) affects hydroperiods (temporal fluctuations in water levels) by controlling the water balance and water storage within a wetland.

Inputs include precipitation, surface runoff, and groundwater inflow. However, to underestimate the total inflow, groundwater inflow is set to zero. Outputs consist of evapotranspiration, downward groundwater seepage, and surface water outflow. However, **surface water outflow is controlled by the PP** with the construction of boundary walls and hence the degree of uncertainty is assumed lower for estimating the water budget.

Water Budget Component	Typical Estimated Uncertainty (%)	Description
Surface Inflow	NA	Related to Precipitation. This is conservative.
Precipitation	2%	NA

Surface Outflow	1%	Controlled by the PP due to boundary wall design.
Change in Storage/Infiltration	20%	Estimated accuracy of change in storage calculation based on field-scale water budget calibration to observed water levels.
Evapotranspiration	20%	Clemmens and Burt, 1997; typical accuracy based on free water surface evaporation coefficient.
Deep Percolation/Groundwater Seepage	2%	The groundwater seepage estimates for wetlands compared with other estimates calculated as the residual of the total water budget are reported to have an error of 7 percent for three-month periods and 2 percent when compared on a yearly basis (***Rushton, 1996***).
Total		**45%**

A.11. Quantification Tools

The precipitation component of the wetland water budget is measured from nearby weather stations. Total precipitation is made up of interception, throughfall, and stemflow. Interception is the amount of precipitation that is retained by the vegetation and throughfall is the amount of water that reaches the ground below. Stemflow is the water that passes down the stems of the vegetation and can be minor depending on the vegetation.

Type of Area	Recommended Runoff Coefficient (K)
Commercial & Industrial	0.9 (source UWR RoU Standard)

Plot Number	Area (m^2)	Comments
15	15808	
16	27592	

17	16151	
18	44656	
19	30874	
20	56909	
21	37065	Developed into commercial in 2021
22	37497	
23	28028	
26	40327	
27	40322	
28	40059	
33	14091	
34	19361	
35	28139	
24	20994	

Baseline scenario

The baseline scenario is the situation where, in the absence of the project activity, the PP would have

- not constructed artificial retention pits and rainwater runoff would be diverted to the storm water drains that currently facilitate the collection of rainwater run-off from the hardscape areas (roads, pedestrian pathways) towards the main gate, where it meets the city storm drain at the main road and hence no groundwater recharge would occur within the project boundary.

Hence the baseline scenario applicable is:

"the net quantity of rainwater runoff captured/harvested each year and/or transmitted towards groundwater recharging."

Harvested water or Volume of water utilized (m^3) = Area of Catchment / Roof / Collection Zone (m^2) X Amount of rainfall (mm) X Runoff coefficient *Uncertainty Factor

Wetlands receive water directly when precipitation falls on the wetland or indirectly when precipitation falls outside the wetland and is transported to the wetland by surface or groundwater flow.

Quantification:

Year	Catchment (m2)	Total (m3)	Post Degree of Uncertainty Applied (RoUs Generated)
2014	**497873**	259979323.1	142988
2015	**497873**	189204186.8	104062
2016	**497873**	149454504.4	82199
2017	**497873**	259513314	142732
2018	**497873**	136218052.8	74919
2019	**497873**	381769016.4	209972
2020	**497873**	409998415.5	225499
2021	**460808**	232661959.2	127964
2022	**460808**	136947068.7	75320
2023	**460808**	218561234.4	120208
Total			1305863

A.12. UWR Rainwater Offset Do No Net Harm Principles

The project activity is located in suitable hydrogeological situations, are environment friendly and economically viable proposition.

The groundwater recharge wetlands have advantages of being free from the adverse effects like inundation of large surface area, loss of cultivable land, displacement of local population, substantial evaporation losses and sensitivity to earthquakes. No gigantic structures are needed to store water.

These artificial wetlands enhance the microclimate and will improve the ground water table till all the vacant plots are developed as part of the SEZ development progresses in the coming years.

Since the project activity falls under Area Development clause No.8 (b) of category "B1" as stated in Environment Impact Assessment Notification published on 14th September 2006 & its amendments and hence the PP is required has to obtain the Environmental Clearance from SEIAA, Gujarat.

The project activity is located in notified industrial area hence no displacement of population has taken place. There is no protected area notified under the Wild Life (Protection) Act (1972) & Eco-sensitive area notified under Section 3 of the Environment (Protection) Act- 1986 within 10 km radius areas from the project boundary.

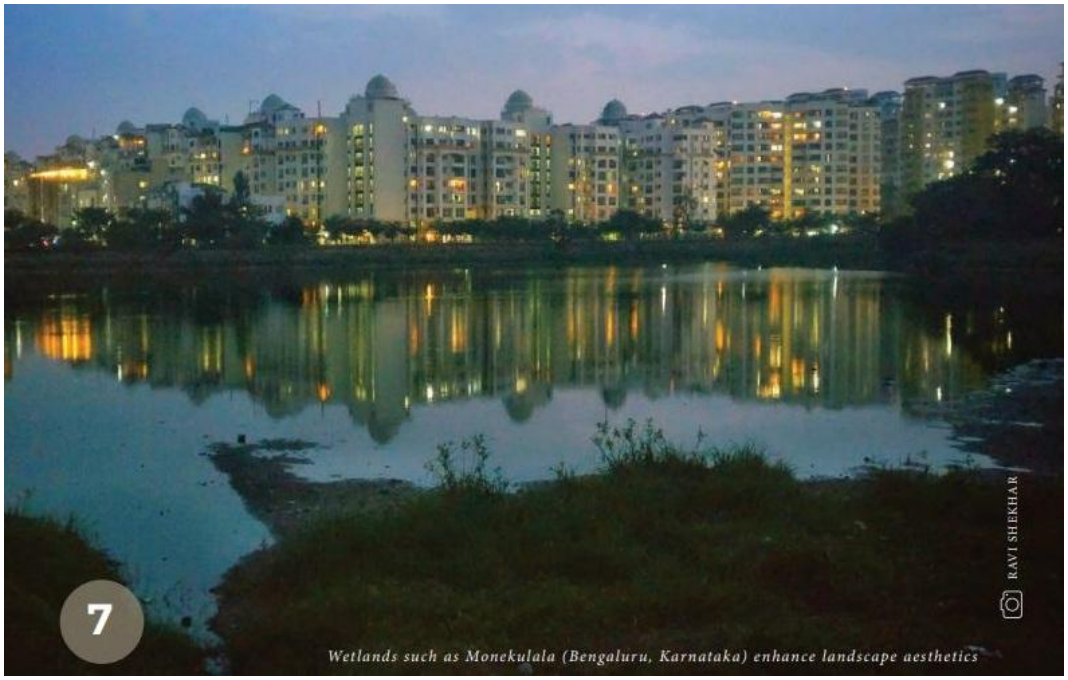
According to the UWR RoU Standard principles, the project activity accomplishes the following:

• *Increases the sustainable water yield in areas where over development has depleted the aquifer*
According to the data released by the Central Groundwater Board in 2021, the total amount of groundwater that can be utilised in India in a year is 398 billion cubic meters (BCM), of which, approximately 245 BCM is currently being utilised, which is about 62 per cent of the total. But the level of exploitation of groundwater is very high in States like Punjab, Rajasthan, Haryana, Delhi and Tamil Nadu. This project activity was commissioned in 2012, and the PP has recharged groundwater that could be used in the future from unutilized water resources. Revenue from the sale of UWR RoUs will enable scaling up of such project activities.
• *Collect unutilized water or rainwater and preserve it for future use*
In India, at the district level, in 24 states/UTs, as many as 267 districts had stages of groundwater extraction more than 63 per cent, ranging from 64 per cent to 385 per cent (source: https://www.business-standard.com/article/current-affairs/from-58-to-63-india-pumped-more-groundwater-between-2004-and-2017-121122101377_1.html). This project activity serves as an example to recharge groundwater with rainfall runoff and encourages companies, especially large and transnational companies in the biotechnology and pharmaceuticals sector, to adopt similar sustainable practices in regards to captive future water requirements and groundwater management.
• *Conserve and store excess water for future use*
The project activity decreases the dependence on groundwater, thereby preventing excessive depletion. Between 2014 and 2023, the project activity has recharged groundwater with **1305 million litres** of rainwater runoff.

Ecological and Environmental Sensitivity (Within 10 Km):- WLS-Wild Life Species; NPA-Notified Protected Area; ESAs-Eco Sensitive Areas; ESZs-Eco Sensitive Zones			
S. No.	**Details of Ecological Sensitivity**	**Name**	**Distance from the Project (Km)**
(1.)	ESAs	none	0
(2.)	Critically Polluted Area	none	0
(3.)	NPA	none	0
(4.)	Corridors	none	0
(5.)	ESZs	none	0
(6.)	WLS	Nal Sarovar Bird Sanctuary	36.7
(7.)	Wildlife Corridors	none	0

Notification	Date
FORMAL APPROVAL BY BOA, NEW DELHI:	21/06/2006
NOTIFICATION GOI New Delhi :	28/09/2006
PERMISSION FROM GUJARAT GROUND WATER AUTHORITY, GoG, Gandhinagar	05/09/2006
N.O.C. FROM G.P.C.B. Gandhinagar	14/09/2006
DEMARCATION OF AREAS by DEVELOPMENT COMMISSIONER KASEZ	06/11/2006
AUTHORISED OPERATIONS, Director, SEZ, New Delhi :	13/02/2007
Addition of 1.4585 hectares land	06/10/2016
Addition of 64.4823 hectares land in PHASE-II	04/09/2017

A.13. Scaling Projects



While cities in India are facing water supply and demand issues, India's water sources – groundwater, rivers and other water bodies – are facing contamination from domestic and industrial pollution leading to deteriorating water quality. Direct disposal of untreated wastewater and fecal sludge into the open, increases the burden of cities to provide drinking water supply to its residents.

India's wetlands/water bodies are being systematically converted into "real estate' by vested interests or simply used as a dumping ground for sewage and garbage and are receptacles for toxic waste. While community and court actions are in process across the country, the lack of enforcement of legal instruments has hampered any real progress in many of these cases.

The intensity and severity of urban floods are on the rise. With climate change, rainfall is becoming more intense, concentrated over short spells, and generating high runoff. As floodwater tends to accumulate in low lying areas as wetlands, infrastructure created on encroached wetland area and feeder channels become exposed to flooding risks. Reduced floodwater accommodating capacity leads to larger areas being impacted. This has been evidenced in several cases, such as Kashmir Deluge of September 2014, Chennai floods of November-December 2015, and more recently in the Kerala floods of August 2018.

Urban wetlands, continue to be encroached upon, polluted, and converted for alternate usages. An analysis of cases pertaining to wetlands in National Green Tribunal since 2010 indicated that

of the 33 cases, 25 related to urban wetlands. Commercial construction activities (14 cases), illegal dumping of waste (11 cases) and residential construction (8 cases) were the most rampant violations.

There is a valid concern whether states, which have been entrusted to play a significant role as per the 2017 Wetlands Rules, would be able to make informed decisions for wetlands in the face of local political and development pressures. In several cases, even courts have favoured developmental activities over maintenance of wetlands, mainly in the absence of systematic evidence base and understanding of wetlands functions (*source: https://south-asia.wetlands.org/wp-content/uploads/sites/8/dlm_uploads/2019/02/Sarovar-Vol-4.pdf*).

National Wetlands Statistics

Type-wise area estimates of wetlands in India

https://indianwetlands.in/wetlands-overview/national-wetlands-statistics/

Sr. No.	Wettcode	Wetland Category	Number of wetlands	Total wetland area	% of wetland area	Open Water	
						Post-monsoon area	Pre-monsoon area
	1100	**Inland Wetlands – Natural**					
1.	1101	Lake/Pond	11740	729532	4.78	454416	**198054**
2.	1102	Ox-bow lake/Cut-off meander	4673	104124	0.68	57576	**37818**
3.	1103	High altitude	2707	124253	0.81	116615	**109277**
4.	1104	Riverine wetland	2834	91682	0.60	48918	**29739**
5.	1105	Waterlogged	11957	315091	2.06	197003	**112631**
6.	1106	River/Stream	11747	5258385	34.46	3226238	**2628182**
	1200	**Inland Wetlands -Man-made**					
7.	1201	Reservoir/Barrage	14894	2481987	16.26	2260574	**1268237**
8.	1202	Tank/Pond	122370	1310443	8.59	916020	**349512**
9.	1203	Waterlogged	5488	135704	0.89	85715	**33822**
10.	1204	Salt pan	60	13698	0.09	5293	**2599**
		Total • Inland	188470	10564899	69.23	7368368	**4769871**

Focus on hard-infrastructure solutions

The dominant urban planning approaches in India so far have been infrastructure oriented, enabling tapping upstream sources for meeting water needs and sending waste and run-off to downstream reaches in the shortest possible time.

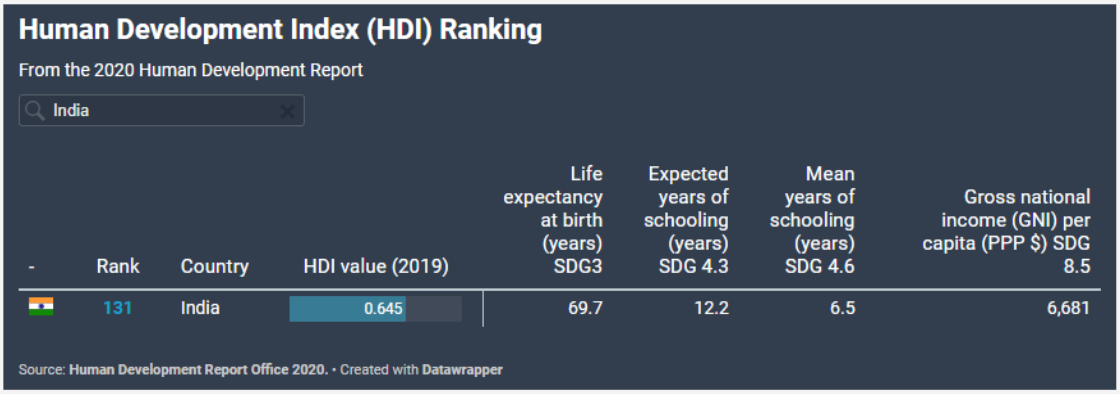
The limitations of such approaches are evident in cities being parched, exposed to floods and droughts, and increasingly water insecure. Management of wetlands located within the boundary of urban areas is often missed out within these approaches.

Furthermore, wetlands globally have been fragmented by human activities (e.g., land drainage), leading to reductions in the connectivity needed to maintain the integrity of ecosystem functioning. Globally, wetland area has declined by 87% since 1700, by 64–71% since 1900, and by 35% since the 1970s.

Although constructed wetlands can offset some of the damage caused by the loss of natural wetlands, man-made systems cannot provide the same ecosystem services as natural environments (source). The future of urban wetlands is closely linked to the extent to which these ecosystems are integrated within the urban developmental planning processes. With the support of the UWR RoU Program, man-made wetlands can be offered as natural infrastructure solutions which are self-sustainable solutions. Recording wetlands as a separate land use class can be instrumental in thwarting the threats of wetlands encroachment and conversion.

Revenue from the sale of the UWR water credits (RoUs) sale could incentivize and provide a "wetland ecosystem service valuation" that can help better decision making related to use and management of natural resources and allows for their incorporation in public ecosystem and biodiversity protection decision making.

Appendix 1



Human Development Index (HDI) Ranking

From the 2020 Human Development Report

India

-	Rank	Country	HDI value (2019)	Life expectancy at birth (years) SDG3	Expected years of schooling (years) SDG 4.3	Mean years of schooling (years) SDG 4.6	Gross national income (GNI) per capita (PPP $) SDG 8.5
	131	India	0.645	69.7	12.2	6.5	6,681

Source: **Human Development Report Office 2020.** • Created with **Datawrapper**